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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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NOTES AND COMMENTS.

Foundry Pig-Iron.

During the spring, attention was called at the Manchester meetings of the Institution of British Foundrymen to the serious variations in the composition of different brands of foundry pig-iron, and now Mr. W. C. Poole, managing director of the Keighley Laboratories, Limited, resurrects the question in our correspondence columns. In doing so, he rightly points the time has arrived when pig-iron makers should not only work to specification, but should also guarantee the composition of their product to lie within definite limits. Once this has been established the foundrymen could then initiate a campaign for the universal provision of machine-cast pig-iron, the outstanding advantage of which is cleanliness associated with lower transport, net weight and flux costs. If the pig-iron makers are of opinion that the grading by analysis instead of by fracture would leave stocks of unsaleable pig-iron on their hands, they are entirely wrong. Once the system of buying by analysis is thoroughly introduced, it will soon be realised that "bad iron" of known composition has a better chance of being economically absorbed by the market than under the present conditions.

In an article, which appeared in a recent issue of "The Iron Age," Mr. Y. A. Dyer defines "bad iron" as iron which, from a metallurgical point of view, has been misused. He maintains that "where cupola operations and accessory conditions are correct and the character of the iron is known through chemical knowledge and experience, there should be no such characterisation as 'bad iron'—though the expression is used with emphasis by seemingly well-versed foundrymen. An intelligent study of foundry formulæ and mixtures for specific castings should readily suggest the best suited pig-iron and scrap for such work. Hence, should 'bad irons' be knowingly used, then the fault should be chargeable to the mixer, not the mixture." According to Mr. Dyer, there are two types of bad pig-iron, the one containing high sulphur and low silicon, and the other oxidised or poorly carburised irons, both being due to blast-furnace troubles.

The question of oxidised pig-iron is always interesting, as it is difficult to imagine why the dissolved ferrous oxide does not attack the silicon present, with the consequent production of metallic iron and silica. According to evidence which Mr. Dyer gives, there must be an important temperature factor, because the reaction outlined above is the one utilised daily in steel manufacture.

Mr. Dyer's views and experiments may be summarised as follows:—

"Iron oxide is soluble, to a moderate extent, in liquid metal, but as a whole does not remain dissolved while the iron solidifies. The ferrous oxide (FeO) being very unstable absorbs additional oxygen, changing to ferric oxide (Fe_2O_3), thus supplying the oxygen which unites with the carbon of the metal, evolving carbon monoxide (CO), resulting in blowholes and segregation if the gas and oxide are trapped.

"Iron oxide is probably directly or indirectly responsible for more foundry ills than any other agency. At times, unfortunately, a foundryman may receive from a furnace company, iron which has been badly oxidised by irregularities of furnace practice. In this manner a large percentage of ferrous oxide may be carried through the cupola and temporarily, at least, held in solution with the liquid metal. To verify this a test of two heats was made by using several thousand pounds of a pig-iron which had every indication of being oxidised.

"In this case, cupola conditions were checked closely and proved to be ideal. The metal came down hot, and was held for several minutes in a 12,000-lb. ladle, being skimmed several times. However, scoria would quickly reform on top of the metal. It was then transferred to small ladles, and by such process the agitation in pouring still further precipitated a large quantity of scoria, which was also skimmed. In pouring the metal into the moulds the further agitation precipitated more slag, which passed through the mould and appeared on top of the riser metal. An analysis of this scoria was as follows:—Silica, 17.40 per cent.; alumina, 3.30 per cent.; lime, none; iron oxide, 16 per cent.; iron, 60 per cent.

"This is not strictly a slag, as no lime is present. The silica and alumina were doubtless gathered from the mould. The castings were full of blow-holes and pin-holes beneath the surface, but always on the cope side."

Whilst we cannot quite agree with all the above conclusions, they, associated with experiments which we have made on very high silicon steel, certainly lead to the view that the reactions between ferrous oxide and silicon and carbon are largely controlled by temperature.

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Company News.

Steel Company of Canada, Limited.—Ordinary dividend, 1¾ per cent. for quarter ending June.

British Hydraulic Foundry Company, Limited.—Interim dividend, 5s. per share, free of tax.

Tredegar Iron & Coal Company, Limited.—Final dividend, 5 per cent. actual upon both classes of shares, free of tax.

Pather Iron & Steel Company, Limited.—Dividend, 4s. per share, less tax, for year; depreciation, £4,000; carried forward, £13,461.

Irvine's Shipbuilding & Engineering Company, Limited.—Participating preference dividend, 8 per cent. per annum, less tax, for six months.

S. P. Austin & Son, Limited. — Profit, £19,078; brought forward, £59,842; ordinary dividend, 10 per cent., free of tax; carry forward, £61,999.

Marine Auxiliaries Engineering Company, Limited.—Capital £1,000. Permanent directors: A. Curtis, D. Cable, and S. J. Coxell. Registered office: 283, Victoria Dock Road, West Ham.

Elton Levy & Company, Limited.—Capital £35,000 in £1 shares, to carry on the business of metal merchants. Registered office: Granville Park Works, Brettenham Road, Edmonton, N.

The Mint (Birmingham), Limited. — Net profits, £44,635; brought forward, £14,417; final dividend, 5s., and bonus, 35s. per share, making 45s. per share, free of tax, for year; carry forward, £20,892.

Thermics, Limited.—Capital £200 in £1 shares (100 A and 100 B). Permanent directors: W. W. Nobbs, S. Evling, A. B. C. Licence and P. A. Lothbury (formerly P. A. Laubach). Registered office: 2, Falcon Square, Aldersgate Street, E.C.

G. R. Cowen & Company, Limited.—Capital £30,000 in £1 shares (10,000 10 per cent. cumulative preference), to carry on the business of engineers, millwrights, etc. Secretary: W. H. Perry. Registered office: Beck Works, Brook Street, Nottingham.

Yorkshire Iron & Coal Company, Limited. — Profit, £122,006; brought forward, £42,034; available, £164,040; five years' arrears preference dividend paid last August, and further distribution of 3½ years' arrears will be paid in July; debenture redemption fund, £6,030; taxes and contingencies, £40,000.

Davy Bros., Limited.—Brought forward, £14,968; profit, £35,582; less intermim dividend, January, 1921, £10,000; available balance, £40,551; final preference dividend, making 7½ per cent. per annum, less tax, £3,000; final ordinary dividend making 7½ per cent. per annum, less tax, £17,000; carried forward, £20,551.

Personal.

THE late Mr. Albert Alexander Smith, engineer, 33, Falkland Mansions, Glasgow, left £6,024.

MR. DAVID ORR, metal merchant, Royston, late of Sherbrooke Avenue, Pollokshields, left £11,399.

THE senate of the University of Durham have conferred the honorary degree of Doctor of Science on Mr. James T. Milton, M.Inst.C.E., in recognition of his eminence as a marine engineer.

MR. R. W. FOWLER, Hartshead, Sheffield, at a meeting of the Associated Millowners, held at the Cutlers' Hall, Sheffield, was appointed engineer to the Association in the place of Mr. Peter Marshall, who has retired from practice.

MR. FREDERICK FISHER, who has been associated with the firm of Rudolf Wolff & Company, metal merchants, 36, Lime Street, E.C.3, for over thirty-eight years, is retiring from business, and Mr. Philip Robert Wolff is being admitted into partnership.

Deaths.

THE death has occurred, after a short illness, at his residence, Ninth Avenue, Newcastle, of Mr. R. Pickering, for over forty years connected with the clerical staff of Messrs. Armstrong, Whitworth & Company, Limited, Walker.

SIR HERBERT BABINGTON ROWELL, K.B.E., Chairman of Messrs. R. and W. Hawthorn, Leslie & Company, shipbuilders and engineers on the Tyne, died suddenly at his Northumberland seat, Redesmouth House, on June 23, at the age of 61.

THE death has occurred of Mr. William Burnyeat, of Millgrove, Whitehaven, at the age of 71. Mr. Burnyeat, who was well-known in the industrial life of West Cumberland, had been associated for the past forty years with mining, iron, and railway undertakings, and the general development of trade in the country.

Gazette.

CRESCENT ENGINEERING COMPANY, LIMITED.—A resolution has been passed that the company be wound up voluntarily. Mr. B. Collinge, 30, Spring Gardens, Manchester, C.A., has been appointed liquidator.

CANADA PACIFIC IRON & STEEL SYNDICATE, LIMITED.—Petition for winding up presented, April 12, by Sir John R. Wright, Widcombe Manor, Bath. Messrs. Cox & Company, 17, Tower Royal, Cannon Street, E.C., solicitors.

THE GENERAL ENGINEERING COMPANY (SALFORD), LIMITED, are being wound up voluntarily. Mr. E. Reynolds 25, Lower Mosley Street, Manchester, and Mr. J. G. Bradburn, 25, Acresfield, Bolton, have been appointed joint liquidators.

LANGHAM STEEL COMPANY, LIMITED.—Petition for winding up presented, June 25, by Mr. A. W. Wheeler, 12, Belsize Park Gardens, Hampstead, accountant. Hearing, Royal Courts of Justice, Strand, July 12. Messrs. Sparks, Whitehouse, Russell & Company, 32, Walbrook, E.C., solicitors.

MESSRS. J. H. CHESHIRE, H. D. Cheshire, W. S. Pooley, and J. R. Chater, weighing machine manufacturers, etc., 25, Bath Street, Liverpool, and Husbands Bosworth, trading under the style of Cheshire, Pooley & Company, have dissolved partnership. Messrs. W. S. Pooley and J. R. Chater will continue the business.

THE partnership (if any) hitherto subsisting between Messrs. Maurice Arthur Hardyman and Stanley Heath, trading as Hardyman's Scientific Engineering Company, 25, Old Dover Road, Blackheath, S.E., manufacturers of model steam turbines, boilers, etc., and scientific instruments, has been dissolved. Business will be carried on by M. A. Hardyman under the same style.

MR. JOHN BELL has been instructed by Messrs. Baird Smiths, Muirhead & Guthrie Smith, who are acting as law agents on behalf of the executrix of the late Mr. Albert A. Smith, of Messrs. Albert Smith & Company, 60, St. Enoch Square, Glasgow, to pay all debts due by him up to and including the date of his death, February 17, 1921. The entire stock, furnishings and plant of the late Mr. Smith, have been taken over by him as at February 17, and the business will be carried on as usual under the name of Albert Smith & Company, at the above address.

Publications Received.

MESSRS. METROPOLITAN-VICKERS, LIMITED. "Individual Drive Control of Machine Tools."

THE INDUSTRIAL LEAGUE AND COUNCIL. "The Journal of Industrial Welfare for June," price 9d.

THE NATIONAL PHYSICAL LABORATORY. "Report for the year 1920." Price 5s. net.

THE WITTON-KRAMER ELECTRIC TOOL AND HOIST WORKS (Proprietors: The General Electric Company, Limited), Witton, Birmingham. "Witton-Kramer Electric Lifting Magnets." Lists No. W.K. 44, and 43.

MESSRS. THE GENERAL ELECTRIC COMPANY, LIMITED (G.E.C.), Magnet House, Kingsway, London, W.C.2. "Kingsway II." Miners' electric hand lamp, charging racks, and maintenance equipment.

DEPARTMENT OF OVERSEAS TRADE. "General Report on the Trade and Economic Conditions of Turkey, January, 1921," by Capt. C. H. Courthope-Munroe. "Report of the Trade and Commerce of Ecuador, February, 1921," by Mr. Acting Consul General W. C. Graham. "General Report of the Economic Situation in Switzerland, April, 1921," by Mr J. R. Cahill.

A Foundry Technical Library.

The British Cast Iron Research Association intend, as part of the Bureau of Information, to establish a technical lending library from which members can borrow any technical book, and have it sent to them to any part of the country. The library will be made as complete as possible, and embrace all the metallurgical and technical books that bear directly or indirectly upon the industry. As a technical library it will be the only one in this country, and will be a most valuable boon to foundrymen generally. Under the rules of membership managers, works chemists, and any foundry employés can join the Association as associate members at a nominal subscription, and can borrow books from the library.

Pouring Castings without Runners.

By E. Ronceray.

M. D. Mathu, writing in the January issue of "La Fonderie Moderne," criticises the inventor of the Brunelli process, and blames him in particular for the explanations given in his prospectus. It is evident that if the prospectus agrees with the reproduction of it which is published, it does contain erroneous explantions of results obtained.

In 1913 L'Association Technique de Fonderie inaugurated a competition on the study of phenomena taking place in the moulds. Although numerous replies were received, the committee considered that the field of research in this direction was so large that they decided to keep the

FIG. 1.—WEIGHT OF CASTING 81 LBS. DIAMETER OF JETS 5/16 INS.

competition open from year to year, the competitors to give experimental proofs in support of their views. It was hoped by this method to throw some light on some of the many phenomena of which the effects are known, but the causes are still obscure. Unhappily, the war put a stop to the activity of the Association, and up till now it has not recovered its usefulness.

All who write articles on what takes place in the moulds should be most careful when the determination of causes is in question. In the true scientific spirit which demands that results should be rigorously checked by systematic experiments, leaving out all factors save that of which the influence is sought, they should verify their assertions under the most severe conditions. Without such verification no assertion should be made.

Thin jets, which appear to have been used systematically for the first time by Brunelli, give unmistakable results, and frequently permit of the complete suppression of risers and runners.*

The latest experiment made is that of the casting (a screwed extension piece for a moulding machine) illustrated at B, Fig. 1. The casting weighs 81 lbs., is machined all over, and must be perfectly sound. A series of 50 castings were poured with two jets of 5-16 in. diameter placed as shown in the photograph, with practically no wasters, the metal being perfectly close-grained. We should say that this method was employed by us in the circumstances as a makeshift.

The preference of the author would have been for a thin jet of nearly the same section, but *en chute*; that is, by means of a narrow jet traversing the central core. This method will be adopted for future castings, but in the circumstances it would have been necessary to make a cope to get this result. As there was no time, and the castings were wanted immediately, top pouring with two narrow jets was resorted to for the sake of speed and simplicity, and this with complete success.

An extreme experiment was made by closing one of the two jets, so that a casting of 60 lbs. was poured by a single jet of ¼ in. The casting came out well, but, owing to the extreme slowness of filling up the mould, this latter method had a tendency to choke. This casting is shown at C, Fig. 1.

Lelong, Mairy, and Mathu decribe immediately after the Brunelli process jet basins which, without any doubt, give perfect refining. It is only necessary to use one of these jet basins with an exaggerated jet to prove that the refining of the metal plays but a secondary part, although an important one. The factor of success is the section of the jet. Brunelli states that in many cases he did away with runners and vents; Mathu denies the possibility of doing so. It is, however, a fact. Up to now the author has not been able to suppress them in every case, but he has succeeded in the greatest majority, notably in the casting above. M. Lamoureux, in his article in the "Revue de Fonderie," confirms this.

In founding there are many unknown factors; for instance, the law of contraction of the metal is little understood. A cooled casting is presumed to have smaller dimensions than a hot casting or than the pattern which has served for the mould. It is also established that the contraction is variable according to the shape of the casting, and that the explanations given of these variations do not suffice to satisfy a scientific mind.

Thus certain cavities have the same dimensions as the core which has reproduced them; the shrinkage does not depend only on the speed of cooling, but changes with the shape of the casting. Often it is not the same in all dimensions of the same piece of regular thickness. Lastly, and above all, nothing is known of the density of the hot casting.

The curves of Keep and Turner give indications of the variations of length in a bar of metal between the temperature of solidification and of complete cooling. They show that the phosphoric metal undergoes three expansions during cooling, notably that a large expansion immediately follows solidification. But what takes place before solidification? Practically nothing is really understood, as scientific research on a liquid with a temperature of 1,200 to 1,400 deg. C. is so difficult.

If a scale of density at the temperatures above that of solidification of the metal were available, it would be possible to understand certain phenomena which are at present incomprehensible, and very likely attain systematically, new progress, which now we can only get by the long process of groping.

Metal, like water, can be conceived as a body which possesses the property of expanding when solidifying. Because we have always seen it, it seems natural that ice takes up a larger volume of space than the water at zero which has produced

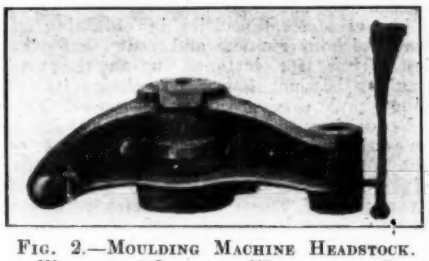

FIG. 2.—MOULDING MACHINE HEADSTOCK. WEIGHT, 320 LBS. WEIGHT OF JET, 7¾ LBS.

it, but this phenomenon is rare in nature. Water at a high temperature contracts at first to 4 deg. C., then on re-cooling expands again—so much, indeed, that it bursts its container. It is possibly the same with the metal. All founders know that a piece of cold metal—consequently more dense than a piece of hot metal—will float on liquid metal.

This phenomenon shows itself no matter what is the size of the piece of metal thrown into the ladle, therefore it is very difficult to admit that this phenomenon is caused by surface tension. It is equally well known that a cylindrical mould does not resist the pouring of an interior rim in phosphoric metal: it splits, as has been experienced by the author when trying to cast a grinding-mill pan in a ring of metal all in one single piece.

Failing knowledge of the law which rules the density of the hot metal, it is extremely difficult for the founder to determine the genesis of other phenomena which take place at the moment of

* Throughout this article the word "runner" is meant to imply "feeding head" and "jet," the gate or portion in between the "feeding head" and the casting proper.

solidification, because these phenomena are concurrent, and repeat, contradict, and conceal each other.

It is certain that the gas in the mould is not completely evacuated when the pouring is finished; by some means or other a vacuum caused by the evacuation of gas must be filled. Similarly, if the mould "gives," the vacuum produced by this fills itself in proportion to the pouring. If the "give" ends before the termination of the pouring the vacuum will refill itself, but if it continues afterwards a means must be found to fill it

Thus, if, following the theory generally admitted, that the metal contracts between the temperatures of pouring and solidification, there is

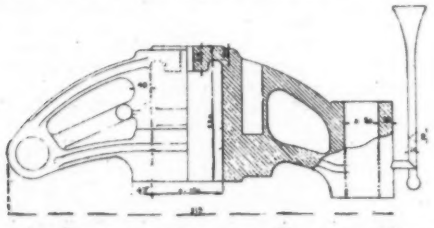

FIG. 3.—SECTION THROUGH THE MOULDING MACHINE HEADSTOCK SHOWN IN FIG. 2.

a new reason for the necessity of finally filling up. Additionally, the action does not take place at the same time and to the same degree of importance in all parts of the mould: the slender parts solidify first, the thicker parts afterwards; thus the strain varies according to size and position.

Suppression of Runners Improves Castings.—The suppression of runners is of great interest, but the question arises as to whether the resulting economy would be nullified by the decreased certainty of success in the casting. It has been invariably found that underneath a runner the metal is coarser than in the rest of the mould. Additionally, it often happens that holes or porous parts are found there. In castings which have to withstand pressure, leakages are usually situated at this place. If, then, one could regularly produce sound castings whilst abolishing runners, a technical interest is added to the pecuniary one, and it was with this end in view that the author decided to undertake systematic research.

It is not always castings which are the most difficult from a moulding point of view which present the greatest difficulties in obtaining sound castings without runners and vents, but are the easiest. Thus, for instance, up to the present the author has not found a method suitable for making simple castings without runners. Neither the Brunelli method nor the narrow jet have given good results. On the other hand 80 per cent. of the machine-moulded castings mostly intended to withstand hydraulic pressure are now cast without runners and vents. Wasters for porosity are unknown; the only wasters, and these rare, are due to ordinary accidents of the trade.

In the case of a small variation of the temperature of the pouring a slight depression is sometimes produced, but under this depression the casting is entirely round, inasmuch it should be understood, as the shape lends itself to the process. A slight thickening of the machinery allowance on the upper part, especially if the surface is large, will remove all cause for scrapping on this group.

Runners and Porous Metal.—The runner may possibly correct certain faults of a defective mould, but it is not without its inconveniences. While it is impossible to say that a shell cast without runner has never shown cracks, or that a casting to withstand hydraulic pressure has never presented defects in watertightness, one can state that porous metal is invariably found beneath a runner.

Monsieur Leonard endeavoured at a conference of the Belgian Foundry Association to point out the causes of these porosities.

Shells Cast without Runners.—During the war M. Leonard cast shells without runners, and although his success was not complete—for he announces "some serious disappointments"—it would seem that these same "disappointments" were profitable. Without agreeing with the theory of contraction that he advances, it can be deduced from his communication that he has succeeded with castings without runners, where he would not have succeeded with them.

M. Leonard bases the greatest part of his theory on the evacuation of gas. He is perhaps right, or partially so. On this subject there are many very interesting experiments yet to be made.

The gas which produces defects in castings comes from many sources; possibly all are not known. Of those which are, there are first the gases produced from the hollow part of the mould; that is to say, from the air which they contain, and, secondly, those produced by the combustion of the mould facing; thirdly, there are those coming from the sand; that is to say, from the decomposition of organic matters, and water with which the sand is damped; and, fourthly, due to the core, and which must find their way as much through the metal as through the mould itself. Finally, there are those which come from the metal itself, and may arise, among other sources, from the air automatically trapped by the metal itself during pouring, or possibly from imprisoned gases.

Making of Moulds.—In well-made moulds, that is to say, made of proper sand, suitably rammed, one can say that the gas always escapes without the necessity of runners and vents, but such a mould is actually an exception.

Methods of Obtaining Perfect Moulds.—To obtain sound moulds it requires great competence by the management to determine what conditions have to be fulfilled, and a firm hand to ensure that these conditions are complied with, for they are usually quite opposite to the ideas of moulders and foremen. It is very probable that M. Leonard has not been able to secure these conditions.

Varied Patterns and Castings.—We have been present at the casting of shells without runners where there were no great amount of wasters. At the present time, when the work turned out constantly varies and is not comparable with the systematic regularity of shell production, where the shapes and objects of the castings are constantly changing, we consider once this method is established, wasters are negligible; that is, in so far as the factor we are studying is concerned. Of course, the usual causes of wasters remain: Carelessness, clumsiness, loose sand, short runs, etc.

Sand and Necessary Properties.—The sand to produce these results should possess a sufficient

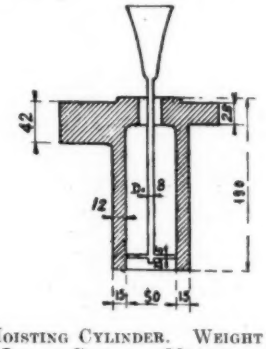

FIG. 4.—HOISTING CYLINDER. WEIGHT OF CASTING 15LBS. IT IS CAST BY MEANS OF TWO ½-IN. JETS.

natural permeability—it ought to be thoroughly rammed, especially if the mould is not dried, but it should not be closely rammed near the pattern. These conditions apply to all moulds produced in foundries, and if one is not willing to assist research up to this point, is it not often because the necessity has not been proved in a sufficiently formal manner, or, even, that often the possibility of realising one or the other has not been credited. It is when these conditions are not complied with that the use of runners and vents augment the chances of success, and that one has to cast in dried sand moulds which otherwise could have been cast in green.

Advantages of Green Sand.—Shells poured according to the ideas enunciated by Bonvillain and Ronceray, could be produced by green sand, while those made otherwise were generally dried.

This showed an important saving. But factors much more important than the saving of money were the increase in production resulting from not having to wait for drying before pouring, as well as making immediate production possible in all foundries without the installation of a drying plant.

Permeability of Sand.—M. Leonard's communication shows clearly that he does not yet possess the means of giving the necessary permeability to the sand, for he has had to go so far as to employ core sand in one part of the mould.

Action of Molten Metal on Sand.—When the sand came in contact with the molten metal, the clay which it contains loses its combined water, and is

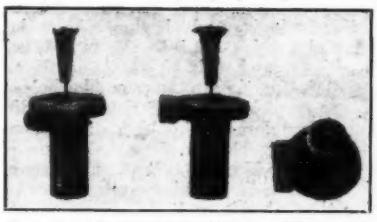

FIG. 5, SHOWING THE CASTING DETAILED IN FIG. 4.

transformed into baked earth; further, it is very probable that grains of silica which are near the casting become loose and transform themselves into dust. Thus, while the burnt clay can no longer play its rôle of binder, the silica dust destroys the permeability of the sand.

Re-use of Sand.—These extreme conditions are not generally realised in founding, where one can, and one ought to in a large degree, use the sand over again, but the parts which have been in contact with the casting are not always completely eliminated, and it often happens that the sand loses not only its strength but also its permeability.

Admixture.—It is customary to strengthen the sand by adding in one form or another new strong sand. Till now nothing has been done, to our knowledge, to give it back its permeability.

It is this reason which makes it necessary to tap off such air to such an extent in the moulds usually made in foundries. It is also a reason for wasters, and, in a great measure, for choking.

Ramming.—In following the instructions given for the making of shells, that is in using a very large proportion of new sand and silicious sand, and in ramming very hard "de loin," that is to say without blows of a rammer, and with considerable pressure, shells can be successfully produced. We do not remember ever having a waster or a choked-up casting when using a mould of this kind.

When we have wished to apply analogous methods to the making of various castings we have remembered these facts, and have adopted the custom when adding strong sand, also to add silicious sand; the first, with the idea of giving body to the sand, and the second, permeability.

It may have been useful to our colleagues to have indicated to them results which may not be new, but which, however, are not very well known. The following opinions are given for what they are worth, being only put forward in order that they may induce others to instigate methodical research on this subject.

Arrangement of Jets to ensure Simultaneous Solidification.—After the experience acquired in three years it seems that success is only obtained with castings where it is possible to arrange the jets in such a manner that solidification approximates to the solidification of the whole—that is, we endeavour to arrange the jet in the part which cools first, and to have the heavy part as far away as possible from this jet. If a shell which has a narrow part at the point and is thick at the bottom is taken as an example, and the jet is placed at the point—that is, at the narrow part, so arranging it that the metal mounts slowly and progressively to the bottom—the desired conditions are somewhere near being fulfilled, as the bottom and the point are solidifying at nearly the same time. This tending to the paradoxical result that, to have a heavy part sound we place it at the top of the mould.

Contraction.—If it is admitted that the normal theory of contraction is untrue, it can reasonably be asked what is the cause which seems to produce sagging, and which up till now has occasioned this misunderstanding. For a long time it has been assumed that the "giving" of the mould, that is, its increase in volume under the influence of the metal, must play a principal part. One can, at any rate, advance credible reasons.

Sagging.—For instance, almost invariably if one weighs similar castings poured as above, those which have not "sagged" are lighter than the sagged ones. It will be admitted that the latter have "given," which can often be proved by the measuring up of the lower part.

Wet and Dry Moulds and Runners.—Another reason is that runners can be done without in certain dried moulds, when they must be provided for the same castings poured in green sand.

Thickness and Runners.—However, if two moulds are made of castings of the same weight and height, one being of a reduced thickness, so solidifying quickly, thus reducing the time for "giving," and the other, massive, the second will require a runner, whilst this can be dispensed with in the first.

Meanwhile our colleagues will probably be interested in the photographs of castings poured under the conditions described by us, and which clearly differ from the usual practice.

In the head-stock of a moulding machine shown in Figs. 2 and 3, the bottom of the cylinder, which is very thick, is placed on the top of the mould and the pouring takes place at one of the ends in the thin part—the socket. The mould is made flat on the joint of a section of 200 sq. mm., that is a triangle with a 20 mm. base, and 20 mm. high (¾ in.). The mould, after closing, is at once put to be cast vertically. The total weight of the gate is 3.5 kilos (7¾ lbs.), and the weight of the casting 145 kilos (320 lbs.), and there are neither vents nor runners. This casting is tested after machining by being submitted to a hydraulic pressure of 100 kilos per sq. cm. (1,422 lbs. per sq. in.); no discard for porosity has ever been made since this process was employed. Considerable rejects for this cause were made when the castings came from outside.

The case of the hoisting cylinder shown in Fig. 4 is perhaps less striking as the casting is not so heavy, but it is 12 mm. (½ in.) thick at the socket and 42 mm. (1.2 in.) at the flange. When these castings were produced by outside foundries wasters ran as high as 80 per cent. Similar wasters were experienced at the author's foundry

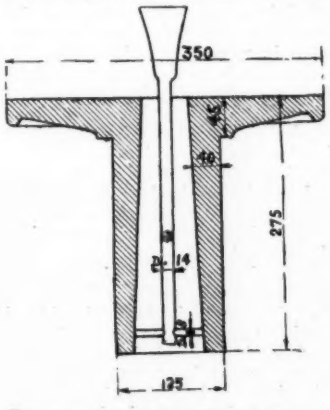

FIG. 6.—SECTIONAL ELEVATION OF SCREWED EXTENSION PIECE. WEIGHT 81 LBS. WEIGHT OF JET ARRANGEMENT 2¾ LBS.

at the beginning when the foremen, left to themselves, used the usual methods with runners on the thick part. These wasters have practically disappeared since the pouring has been carried through the core with a jet of 6 mm. (¼ in.) diameter. The weight of the casting is 7 kilos (15 lbs.), weight of the jet 730 grams (1.6 lbs.). The method of running the casting, which is by means of the two small round ¼-in. jets fed by a central jet, is shown in Fig. 5.

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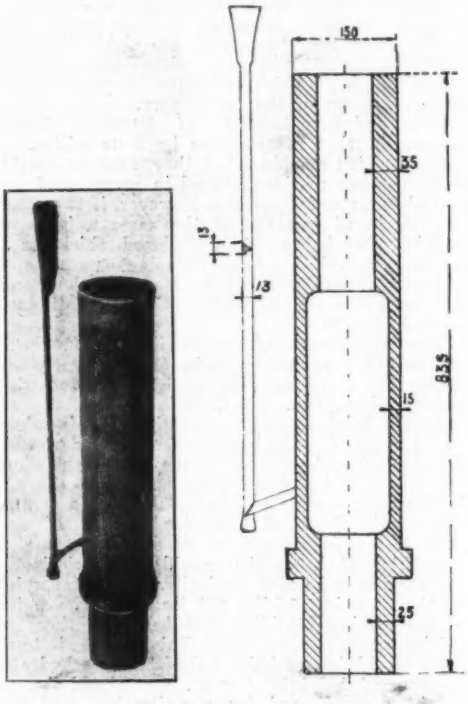
The screwed extension piece shown in Fig. 6 is of the same type as Fig. 1, but it is more striking than the former on account of the weight and thickness being more important. This piece is cast through the core by means of a vertical jet of 14 mm. dia. (9-16 in.) feeding two round ducts of 8 mm. dia. The total weight of the jet is about 1.2 kilos (2.6 lbs.).

Other castings are made in this manner, as, for



FIGS. 7 AND 8.—WEIGHT OF CASTING 116 LBS. WEIGHT OF JET 5¾ LBS.

instance, the column of a moulding machine shown in drawing Figs. 7 and 8, the latter showing the casting with the jet attached. The weight of the casting is 53 kilos (116 lbs.), that of the jet 2.3 kilos (5.6 lbs.); its section is a triangle with a base of 13 mm. (½ in.) and 13 mm. high.

We are carrying out researches for the purpose of ascertaining the section of the jet in proportion to the shape and weight of the casting. The formula now in use gives satisfactory results in a great number of cases, but one co-efficient must be modified according to the nature of the casting. When the flow of the metal increased or diminishes the section of the jet should be slightly altered in the same direction.

Jets, Sections and Weights.—In all cases the section and weight of the jets are small compared with the sections and weights generally used, and, what is more interesting still, porosity due to runners do not exist.

Cooler instead of Vents and Runners.—When the shape does not permit easily of obtaining solidification in mass, it is preferable, in place of vents and runners, to put a chill at the thick end. However, it should be pointed out, the author has never yet been successful, except with castings showing at the same time a thick and a thin part. With blocks and pipes we have not obtained the same satisfaction. Moreover, it is the same with the Brunelli process. If our supposition of the "giving" of the mould till solidification is correct, that can be understood.

Although seeming entirely different, the Brunelli process and that shown by us have, however, very interesting common points, but the view that the results obtained by Brunelli are due to filtration of the metal must be abandoned. Bottom pouring is undoubtedly preferable, but the points in common are numerous, as, for instance, the filling of the mould, which should be done slowly. In this direction, M. Leonard concludes that:—

"In pouring with a narrow jet the rate of flow of the gas being weak, it is possible that the pores of the sand are sufficient to evacuate all the gas formed." It is possible, but the author believes there are yet other reasons.

Another common point is, "the metal becomes refined"; that is, the jet being quite small in both cases, from the first flow of metal it is completely filled, and slag which may be present in the ladle cannot pass if the basin is kept full.

A third common point is the necessity of using very hot metal, without which casting cannot be successful.

These points, which, on the face, seem to be only points of detail, have, in the author's opinion, considerable importance, particularly the last two.

Custer, in a communication to "The American Foundrymen's Association," gave an account of a series of experiments which show that when the molten metal carries air into the mould, whether it is metallic or sand, this air reacts on the sulphur of the metal, forming numerous blowholes seemingly composed of bubbles of SO_2 (sulphur dioxide)

Amongst founders it should be unnecessary to dwell on the importance of not allowing slag to get into the moulds. The large number of processes intended to effect this result suffices to show the value they attach to it.

The Brunelli process and the bottom feeding narrow jet both offer a simple means of preventing slag from penetrating the moulds, but the bottom-fed jet gives the further advantage of avoiding all "working" through the mixing of the metal and the air.

The Brunelli process is superior to the ordinary pouring because "working" is only produced with the air in the mould, whereas the ordinary process allows the stream of metal to trap the outside air. But bottom casting with the narrow jet produces no "working": it produces what the author has named a "gentle flow": that is, the metal mounts slowly and without agitation in the mould, whilst in the Brunelli process the metal falls from the jet right across the mould.

The author has found the Brunelli process to be suitable for casting heavy but flat pieces, or, when they have presented a large upper surface, as in the casting shown in Fig. 1. That may be explained by the fact that the hottest metal being at the uppermost part and the pouring being slow, the metal which is at the bottom of the mould is probably nearing solidification at the end of the teeming. At this moment the "give" is reduced for the upper metal is like a runner with a large transversal section into which one could have introduced hotter metal for feeding the parts having need of it. The efficiency of this feeding is proportionate to the surface of the casting, but it should be pointed out, however, that when the thick part can be put on top and the thin part below, bottom pouring is perfectly successful.

The necessity of using hot metal gives distinct advantages actually, blowholes are rarely found. It is not apparent how much is due to suppression of "working," or how much to the high temperature of the metal, but it is possible to attribute part to the latter cause because blowholes are equally rare in moulds cast by the ordinary process, where one hardly notices any blowholes as such, save those manifestly due to the mould itself.

FIG. 9.—SHOWING THE CASTING DETAILED IN FIG. 6.

Advantages of Fusion at a High Temperature.—This rarity of flaws in castings moulded in different ways gives rise to the belief that melting at a very high temperature presents great advantages, even if the actual pouring is carried out at a lower temperature. In the present state of the science of founding and of our researches one can only surmise the reasons. There is reason to believe

that at a very high temperature (the author insists that the metal coming from the cupola should emit black fumes) the re-actions which it seems should be produced among the different elements of the metal may cease before it enters the mould. All founders know the movement of intense life which the surface of very hot metal shows. Up till now no scientist has unveiled this mystery; but it is certain that if the metal is not hot on leaving the cupola the cast is useless.

It is desirable that systematic researches should be undertaken on this subject; they would probably be productive of practical results, above all, if they were made in the foundry itself with the aid of instruments permitting us to determine at one and the same time all the interesting points—*i.e.*, temperature, density, composition, etc.

After making an appeal for the closer co-operation between the foundry and the laboratory, the author pointed out that the practical man on his side should blame himself for not having persistently sought to determine by experimental method the influence of various factors with which he is in daily contact. It is not necessary that he should have a laboratory at his disposal, nor that he should be a scientist; it will suffice if he remembers that when he wants to study one factor this factor only must be varied, all others must remain rigorously the same; for example, if he is studying the influence of a method of ramming, he must use the same sand in the same box, making the same casting and using the same metal, etc. To study the influence of the temperature of pouring, vary nothing but this temperature, taking great care that all other factors, including the metal, remain the same.

Conclusion.—If the host of intelligent practical men who love their craft of founding would follow these simple instructions the future would hold for us quick and remarkable progress.

[We recently commented upon this subject, and made reference to the above article by Mr. E. Ronceray, which appeared in the May issue of "La Fonderie Moderne." The theory put forward so interested some of our readers, that one of them, the Croydon Foundry Company, has not only taken the trouble to translate the whole of M. Ronceray's article, but has decided to carry out some experiments with a view to either confirming or combatting some of the views put forward.—ED., F.T.J.]

Heat Treatment of Heavy Forgings.

At a meeting of the Washington Chapter of the American Society for Steel Treating, general practice in quenching wristpins, axles, piston rods and connecting rods was described by Mr. Fry, Superintendent of Product, Standard Steel Works, and results of experiments were given to show the effects of various quenching media on the properties of both large and small sections. The rate at which heat units are extracted per square inch of surface in quenching is the same for axles as for small test-pieces when using any one of the common commercial media. The hardening effect, however, does not depend upon the rate at which heat units are given up, but on the rate of temperature drop. The following average figures represent the number of heat units (B.T.U.) extracted per square inch of surface per minute by different quenching media:—Air, 1.0; heavy oil, 2.7; cutting compound, 3.0; light oil, 3.6; water, 7.0.

Vigorous circulation of the quenching bath not only cuts down the time of cooling, but may result in superior physical properties.

The importance of "pre-natal" influences in successful heat-treatment of steel was especially emphasised. The usual inspection reports covering condition of surface and chemical composition were characterised as inadequate in defining the quality of steel for high-grade forgings, and a plea for more general and close scrutiny of melting and forging records by those engaged in heat-treatment was made by Mr. McKinney, Metallurgist, Washington Navy Yard.

L'Avebene.

We have recently received from the Société Anonyme L'Avebene, of 13 rue d'Aguesseau, Paris, some details of Avebene, which is an agglutinant or binder, and is largely used on the Continent for core work. In France,

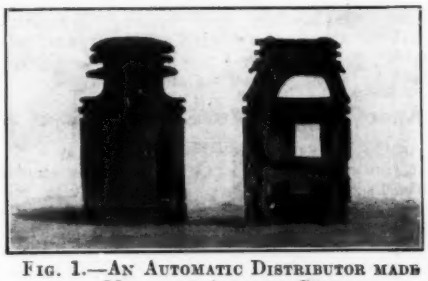


FIG. 1.—AN AUTOMATIC DISTRIBUTOR MADE BY MEANS OF AVEBENE CORES.

especially, it has, in many cases, replaced linseed oil and dextrine (which cost ten times as much), on account of the fact that its combustion gives off no fumes. The manufacturers recommend that it should be used in a very dilute condition, which permits of an even distribution throughout the sand. Cores made by means of Avebene are said to be so strong that in many cases irons can be eliminated. The originals of Figs. 1 to 3 were exhibited at the recent Foire de Paris. Another

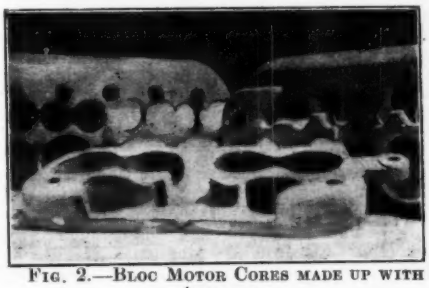


FIG. 2.—BLOC MOTOR CORES MADE UP WITH AVEBENE.

important feature claimed by the manufacturers is the ease with which cores can be removed from the finished casting. Avebene differs from most binders in so much as it contains neither fats nor oils.

The uses of Avebene are not confined to core-making, but extend to the repairing of open-hearth and Bessemer furnaces. In this case we presume that it will be mixed with powdered silica brick and plastered on to the worn portion. A further scope is found for its employ in the agglomerating of

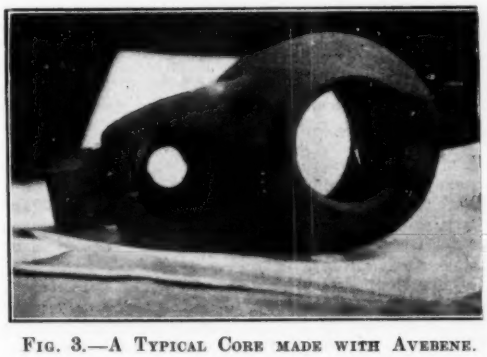


FIG. 3.—A TYPICAL CORE MADE WITH AVEBENE.

turnings or other finely-divided cast-iron, steel or copper scrap, thus rendering them in suitable form for charging into a cupola.

Powdered coke, unfit for cupola work, can be agglomerated by means of Avebene, and so made suitable for burning in stoves or boilers.

"Ruber" and "Niger" are other two compounds prepared for use between prints and cores, the former being suitable for copper and bronze and the latter iron and steel.

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Engineering Conference.

The fifth Engineering Conference of the Institution of Civil Engineers was opened on June 29 in the Hall of the Institution at Great George Street, Westminster, Mr. John A. Brodie (President of the Institution) in the chair. The Conference was attended by representatives from all parts of the British Empire, as well as from the United States, the four leading branches of American engineering—civil, mining and metallurgical, electrical, and mechanical—being represented by distinguished members.

Award of Fritz Medal to Sir Robert A. Hadfield.

At the opening of the Conference the American representatives presented the John Fritz Medal to Sir Robert A. Hadfield, Bt., for his invention of manganese steel. The delegation which presented the Medal was headed by Mr. Ambrose Swasey (General Chairman of the John Fritz Medal Board of Award, and Chairman of the American Society of Mechanical Engineers).

The John Fritz Foundation, from which the medal takes its name, was formed during the life of the famous American engineer and metallurgist, the late Mr. John Fritz, who many years ago was practically responsible for the founding of the great Bethlehem Works in the United States. He was born in 1822, in Londonderry, Chester County, Pennsylvania. In 1902, on his eightieth birthday, the four American engineering societies, namely, the Society of Civil Engineers, the Institute of Mining and Metallurgical Engineers, the Society of Mechanical Engineers, and the Institute of Electrical Engineers, founded the medal to show the high appreciation in which the life-work of Mr. Fritz was held, and to perpetuate the memory of his achievements in engineering progress of all kinds. The medal is only awarded for notable scientific or industrial achievements of the greatest eminence. It is conferred irrespective of nationality or sex, but not necessarily every year. Amongst the past sixteen recipients of the medal are the following twelve Americans and Englishmen:—John Fritz (1902), George Westinghouse (1906), Lord Kelvin (1905), Dr. Alexander Graham Bell (1907), T. A. Edison (1908), Sir William White, K.C.B., F.R.S. (1911), Robert W. Hunt (1912), Dr. James Douglas, the great authority on mining (1915), Elihu Thomson (electrician) (1916), Professor H. M. Howe (metallurgist) (1917), General George W. Goethals, of Panama Canal fame (1919), and Orville Wright, of aeroplane fame (1920).

SIR ROBERT HADFIELD, in acknowledging the presentation, expressed his appreciation of the great honour conferred upon him by the American engineering profession. He returned heartfelt thanks for the manner in which those present had received the announcement of the bestowal of this deeply-prized honour upon him as a British engineer. He regarded it, however, as even much more than this, for in the official announcement from the United States he was told, in Anglo-Saxon words, which usually meant what they said, that the distinction should be accepted by him not only for himself personally, but at this time through him as an expression to the British nation on the part of the engineers of the United States, of their high regard and appreciation of the work of the British engineer in the war for the preservation of civilisation. There was no honour bestowed by the great Republic on a technical profession higher than that which the American engineering profession had seen fit to confer upon him that day. It was a great pleasure to have present American friends who were taking such a leading part in the ceremony, because it was in America where manganese steel first received its encouragement on a large practical scale. In addition, there was a singular appropriateness in this award being conferred before the Institution of Civil Engineers, as the presentation of his (Sir Robert's) original papers on April 28, 1888, giving an account of the invention of manganese steel, took place in the lecture hall of the old building of the Institution. The first specimens of this steel were produced on September 9, 1882, and facsimile copies of his experimental records were shown in the presidential address he gave to the Faraday Society in 1914.

An address of thanks for distribution by Sir Robert Hadfield was also printed in the form of a small volume extending to forty pages, and illustrated with portraits of some of the most notable engineers and scientists of the past and present times. This address of thanks can be divided up into the following sections:—

Material Assistance Rendered by the United States of America to the Allied Cause during the Great War.

The Work of the British Engineer in the War.

The Importance of a Modern Technical Institution.

Mr. John Fritz and his History, also the Names of Recipients of the Medal.

The Work of the United Engineering Society, its Foundation, Council, and Great Building.

Manganese Steel—A Brief Reference to its Invention and Application.

Low Hysteresis Steel.

General Reference to Sir R. Hadfield's Research Work.

The Growth of Science, including a Brief Glance at the History and Work of the Royal Society from its Incorporation in 1662.

Book Reviews.

"Le Modelage Mécanique," by Maurice Champdecler.—(Dunod, 47, Quai des Grands-Augustins, Paris. VI.) Price 22 francs. This book on pattern-making is decidedly of great practical use, and, as one would expect from a French engineer, it introduces much more mathematics than it is customary to find in English textbooks. The book contains 112 pages and 38 plates, of which three are coloured. Additionally to the illustrations given in the plates there are 90 line drawings.

We rather expected that the author would have devoted more space to the determination of cost price, as is usually found in similar French works. Though some excellent ideas as to the fitting up of a pattern shop are given, we consider the book would be improved by giving one or two typical lay-outs.

The series of typical examples of patterns are well chosen, and are not of the extremely elementary character usually found.

A large section of the work is devoted to the actual tools used, both hand and machine.

Probably the most interesting section is that dealing with propeller blades, which the author divides into four sections—the geometry of helical curves, the design of propellers, the construction of propellers and aeroplane propellers.

The book is one which we can thoroughly recommend to both those responsible for the designing and the making of wooden patterns.

BATAVIAN STEEL INQUIRY.—We are informed by the Comptroller-General of the Department of Overseas Trade that the British Commercial Agent for the Netherlands East Indies (Lieut. H. A. N. Bluett) reports the receipt of an inquiry from a Java firm, who are desirous of being placed into touch with United Kingdom manufacturers of iron and steel sheets, angles, channels, rods and bars, also of machinery and tools. The applicants state that they have a foundry and construction shop, and derive their business mostly from the Dutch East Indian Government and partly from the plantations and estates in their neighbourhood. They apparently do not operate on a very large scale, their normal imports of iron and steel material being estimated at some 500 tons per annum. The firm are anxious to get into touch with manufacturers who can be relied upon to supply materials of satisfactory quality and to effect delivery within a fixed period. In this connection it is stated that hitherto the inquirers have been dependent upon supplies of American material, delivery of which is often behind time. The name and address of the firm referred to may be obtained by United Kingdom manufacturers interested on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1, quoting 10779/FW/S.C.(2)

Moulding a Bronze Runner.*

By William G. Leishman.

Runners for water-wheels are very interesting and somewhat intricate articles to make.

The runner in question is for a hydro-electric generator, 22,500 h.p. vertical shaft turbine, to work under a head of 800 ft., and running at 600 revolutions per minute. It is 6 ft. in diameter, has sixteen vanes, weighs approximately 7,600 lbs., and is cast in bronze.

It is neither the size, nor the weight that is remarkable, although a bronze casting of this size and weight is not an every-day occurrence, but it

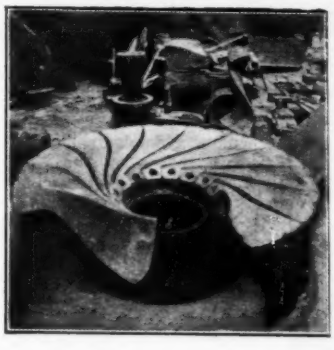

FIG. 1.—VANE CORES ON LIFTING PLATE. THE CORE BORE AND HUB CORE ARE SHOWN IN THE REAR.

is the making and assembling of the cores that forms the interesting part.

In the making of the pattern and core boxes the accuracy shown by the pattern-maker was wonderful, as in no instance a core has been filed or in any way adjusted.

On reference to Figs. 3 and 4, which show two views of the casting, it will be seen that the moulding would not be particularly difficult were it not for the peculiar shape of the cores. By observing both views it will be seen that the vanes were all cast in the bottom half of the mould while the hub was in the top and fastened to the back of the vanes by means of the ribs shown in Fig. 3 From this it will be understood that the bottom

FIG. 2.—VANE CORES ASSEMBLED ON A LIFTING PLATE AND HELD TOGETHER BY A BAND.

of the hub core when placed in the mould will be almost in line with the top of the vane cores.

The pattern is a plain solid block as far as the bottom half is concerned, but the top part is as shown in the casting, Fig. 3. The bottom, an iron ring bored to fit the bottom print, is put in pattern. This ring is rammed into the mould and remains there. Before ramming the cope, the pattern is used as a core-box and a core made and baked. This core is put back in the pattern and rammed up as part of the mould and secured to the bars of the cope.

In the making of the vane cores, after the core is rammed up and part of the core box taken away, great care must be exercised in packing sand in the box back of the core in order to level it up so as to bed-on the plate, as the core is of such a twisted shape, which must be preserved. This can be very materially helped by building bricks in with the backing up sand so as to make a good substantial bearing on which to roll the

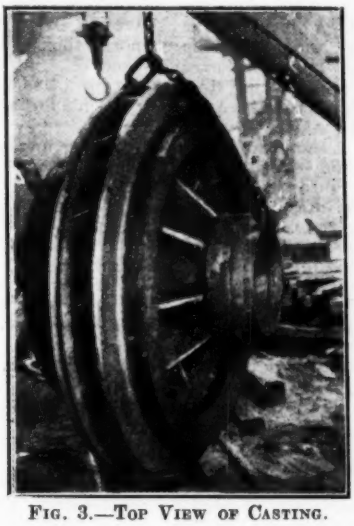

FIG. 3.—TOP VIEW OF CASTING.

core, thus preventing any possibility of it springing out of shape.

These cores must be very carefully vented as the surface is great and almost entirely surrounded with molten metal, and the gas must come off quickly.

After the cores are made, the next step is the assembling of them on a plate the exact size of the bottom print, and incidentally the exact size of the ring described above, as having been

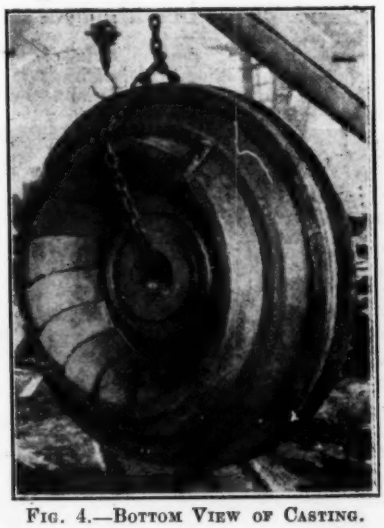

FIG. 4.—BOTTOM VIEW OF CASTING.

rammed into the mould and fitting around the print. This plate is also used for a lifting plate when the cores are ready to be put into the mould.

Referring to Fig. 1, a ring or bushing will be seen in the centre. This bushing is fitted into a groove in the lifting plate and is exactly centred. The vane cores are placed close up against this, by which means extreme accuracy is obtained. It will be seen that eleven of the vane cores are in place. This was a simple enough process, as they were just put there one at a time. The remaining five cannot be placed in this manner, but must be set further back and then all advanced simultaneously, very carefully and slowly, as the pecu-

* racted from the Canadian Foundryman.

liar shape of the cores makes it impossible to do otherwise.

The large foundation plate on which everything rests is prepared by sweeping a smooth and level bed of loam, which is dried. The wooden studs which are visible are cut with great care with regard to depth, as they hold the outer end of the core at exact height. They are left in place till the core is dried.

After all the vane cores are set in position on the lifting plate a band is put around the outside of them and pulled up tight by means of a bolt through lugs on the ends of the band. This will be better understood by reference to Fig. 2. At this stage the joints of the cores are filled up, blacked, and put in the oven till thoroughly dry.

When ready to set the vane cores the crane slings are attached to the lifting plate and the entire group is lifted, leaving the foundation plate and the wooden studs behind.

Fig. 2 shows cores all ready to be lowered into the mould—the lifting plate also serves as a print and fits into the iron ring plate which was rammed into the drag, thereby making a perfect fit and holding the cores in exactly the proper position.

After the vane cores are placed in the mould and the slings unhooked, the iron bushing in the middle is rammed full of sand and struck off level with the groove or shoulder shown near the top edge of it. This groove acts as a print for the centre core.

In the rear of the vane cores, in the illustration, Fig. 1, will be seen the centre core with a disc bottom to fit the print and with four gates just above the bottom. The pouring gate is in the centre of this core, and the metal flows in four directions simultaneously.

The core boxes in which the vane cores were made are seen beside the centre core, and one of the vane cores is also shown leaning against the core box, which shows its twisted nature.

Fig. 3 shows the finished casting ready for the machine shop. This is the cope side of the casting and shows internal flange, which, as already pointed out, has been successfully accomplished by using the pattern for the core box and making a dry sand core which has been put back on the pattern, and the cope rammed up on it.

Fig. 4 shows the other side of the casting with lower edge of vanes in view.

Sand Throwing Machines.

Amongst the latest developments of machine moulding is the one illustrated in Figs. 1 to 4, the first of which shows the general appearance of

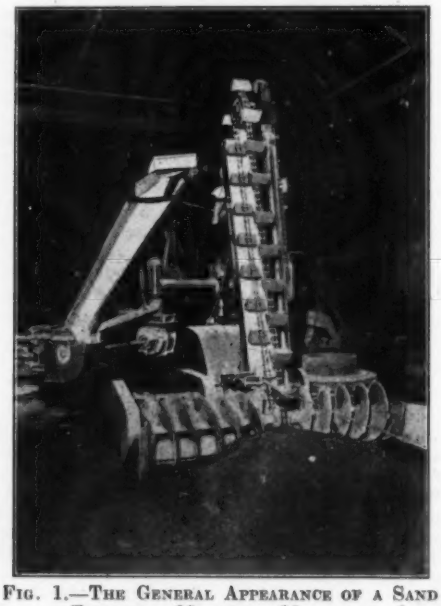

FIG. 1.—THE GENERAL APPEARANCE OF A SAND THROWING MOULDING MACHINE.

the apparatus. The machine is of the mobile type, though stationary plants are also at work. The body of the sand thrower is mounted on racked double track, into which a motor-driven pinion engages for the propelling of the machine. The track, which is 11 ft. wide, is heaped up with moulding sand, and as the machine moves along

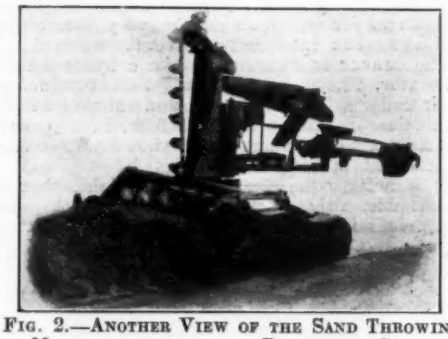

FIG. 2.—ANOTHER VIEW OF THE SAND THROWING MACHINE, SHOWING THE PROPELLING GEAR.

the large worm, shown in Fig. 1, carries the sand to its centre, where a bucket elevator lifts and discharges it into a screen on the moulding side of the machine. A 5 h.p. motor suffices for all these movements. The screen into which the sand falls is driven by a 2 h.p. motor, the discard being taken away by a chute and dropped into a

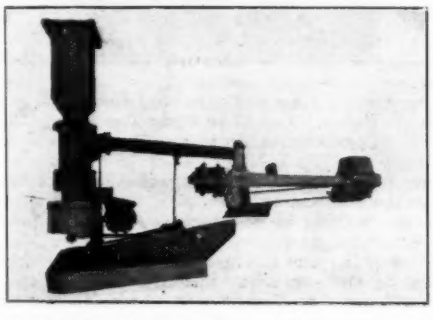

FIG. 3.—THE GENERAL APPEARANCE OF THE BRACKET CARRYING THE THROWING MECHANISM.

box below. The screened sand drops into a hopper and feeds a continuous belt, shown in Fig. 2. This in turn discharges it into a partially enclosed motor-driven paddle, which throws the sand at high velocity into the drag or cope below. The paddle box, shown in Fig. 4, is driven by a 3 h.p. motor, which also serves for operating the belt. The machine shown will throw 12 cub. ft. of sand per

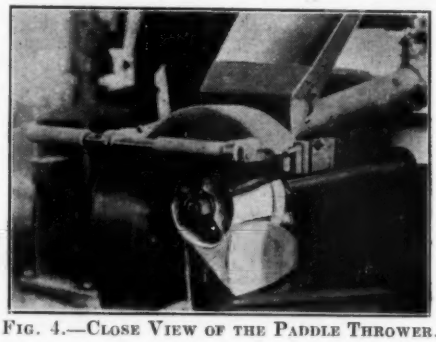

FIG. 4.—CLOSE VIEW OF THE PADDLE THROWER.

minute. In Fig. 3 the general details of the bracket carrying actual sand thrower are shown.

It will be readily realised that this apparatus is totally different from the standard types of moulding machine, in that it throws the moulding sand into box and eliminates all shovelling of sand, which takes machine moulding one step further, as the older type only did away with ramming. The jarring and vibration are also eliminated, which will add to the amelioration of foundry conditions. Some published figures show that it will fill moulds more than six times as quickly as hand ramming, and probably this figure could be exceeded on some jobs. We understand that the British patents are held by the National Light Castings Association.

Control of Corrosion in Iron and Steel Pipe.*

By F. N. Speller.

While there is a vast difference in the amount of corrosion of iron and steel under different conditions, and it has been proved that the relative corrosion of these metals also varies decidedly with surrounding conditions, there are certain fundamental causes which underly all cases of corrosion which should be understood by all who are interested in this problem in any of its phases.

Every metal when placed in water is subjected to a fixed tendency to go into solution. This is wholly a matter of electro-chemical activity, and varies to a definite extent with each metal. Thus the initial reaction in the process of corrosion is analogous to solution in acid, pure water being in effect a very weak acid. The acidity of the water depends on the concentration of the hydrogen ions, which determine the initial speed of attack. As in all electro-chemical reactions, however, the initial speed of solution soon slows down as the numerous little electro-chemical couples which form over the surface of the metal become "polarised," due to the accumulation of hydrogen on their cathodic surfaces, ultimately stopping the solution of the metal.

Ferrous and Ferric Hydrate.—In the case of iron a small amount of the metal (less than 10 p.p.m.) is dissolved as ferrous hydrate, which also has a decided retarding action on the solution of the metal. This, the first stage of the corrosion of iron, while essential, is not a serious matter if the reaction between water and iron can be stopped at this point. As a matter of fact, this reaction cannot proceed unless in some way the hydrogen film protecting the metal is removed. This is usually brought about by means of something in the nature of a depolariser, generally free oxygen, which also combines with ferrous hydrate, forming insoluble ferric hydrate, commonly known as rust.

This, the second stage of corrosion, is thus caused by the oxidation of hydrogen and ferrous hydrate in solution by the free oxygen of the atmosphere. Oxygen is soluble in water at normal temperature to the extent of about ten parts by weight per million (7 c.c.s. per litre), and as water readily absorbs more oxygen when this element is used up, as in rusting under atmospheric conditions, it will be seen that under such conditions the reaction will continue until the metal has been destroyed, or the reaction may be brought to a stop at any time through exhaustion of the supply of available oxygen. The latter case is illustrated in any closed water system, as in the case of metallic water pipe where the amount of free oxygen will be found to drop as the water travels from the inlet, so that if the pipe is long enough the corrosion will finally be reduced to a negligible amount.

Water and oil lines suffer mainly from outside corrosion due to soil conditions, which resemble more nearly corrosion under water than atmospheric corrosion. Underground corrosion may be accelerated by the presence of certain salts or acids in the soil, and by the more ready access of free oxygen either by direct circulation of air or by means of underground waters which have become charged with oxygen and carbonic acid. The corrosive action is greatly increased by a rise in temperature and velocity of water within certain limits, and by contact of the metal with any materials which tend to intensify galvanic action, such as cinders or certain kinds of mixed trench-fill, or even the heavy mill-scale formed in hot-finishing the pipe, which has a strong tendency, where firmly attached, to localise corrosion and cause pitting. Rust once formed on the surface also has this effect to a somewhat lesser extent.

The influence of composition of the metal under most conditions does not seem to have much effect in itself, all other things being equal. Wrought iron, Bessemer steel and basic open-hearth steel pipe has been in service thirty years or more, the records of such lines showing failures in some places and practically no corrosion in other places, depending on soil conditions, drainage and other factors. It is very difficult to make a strict comparison of two or more materials in a pipe line underground, for the reason that the conditions are so variable, but it is significant that wrought iron forged couplings have up to the present generally been used on steel pipe, and so far as we can learn from many cases examined, no difference in the depth of the corrosion has been found, although wrought iron couplings are hammer-forged, and consequently should have a better structure and be more resistant than the pipe. So far as the metal itself is concerned, the factor of prime importance as affecting initial corrosion seems to be the surface finish, particularly the mill-scale, which is decidedly electro-negative to iron, and therefore is a more or less powerful accelerator of corrosion.

Protection Against Exterior Corrosion.—From the above it will be understood that the main object of protective coatings is to exclude water from contact with the metal.

Such coatings as are available at present are by their very nature easily damaged and thus rendered practically useless if subject to abrasion after being applied. No coating has yet been found which has any chance of protecting such a material as an oil-well casing. Most of what follows is, therefore, applicable mainly to line pipe or water pipe subjected to underground corrosion.

Before any coating is applied in the field, all loose rust or scale should be removed and a thin priming coat applied to the clean, dry surface after the line is put together and ready to be ditched. Where a priming coat is applied at the place of manufacture, which is preferable, the surface should be cleaned and freshened before any further protective coating is applied in the field. The subsequent protection needed depends on conditions which should be determined by a careful survey of the nature of the soil and drainage of the territory in which the line is to be laid. Old oil lines which were originally laid without any protection other than a simple coat of paint, as a rule have not given serious trouble for more than 10 per cent. of their length. Therefore, in the interests of economy, it is obvious that the places which are likely to cause trouble should be ascertained and a type of protection selected suitable for each locality. In well-drained sand or clay soils, a second coat of some reputable pipe compound may be all that is necessary, or perhaps one coat may be sufficient, but in wet, marshy places, especially where the ground water is corrosive, a much more substantial waterproofing will be necessary. Wherever the ditch can be drained economically, it will, of course, be of considerable advantage to drain it.

The function of the priming coat is principally to afford a strong bond between the thicker protective coating and the metal, and is essential where the subsequent coat is applied hot to the cold metal. The priming coat may consist of coal tar or a pure asphalt dissolved in naphtha or benzol to a thin consistency. It is of little protective value in itself, as is true of paints in general underground. To be of any practical value where underground corrosion is known to occur a non-porous coating of substantial thickness is required. The coatings which have given the best service may be classified as follows:—

Melted bituminous mixtures which can be safely heated to 175 to 200 deg. C., with a melting point of about 60 deg. C., may be applied in the field with suitable brushes operated by hand or mechanically. Sometimes a coating of this class is poured over the pipe, the surplus being caught in a strip of canvas about 30 in. wide held by two men, by which means the coating can be worked evenly over the underside of the pipe. In this way, with some care and practice, a coating of from 1-16 to ¼ in. thick may be applied without much variation in thickness. The well-known dips applied at the works by manufacturers come under this heading. Conditions are more favourable for the application of these coatings at the mill, but the manufacturer has to take into consideration the problem of transporting the pipe without injury, and is limited as to the coating material by this consideration. Most pipe has to stand a wide

* Paper read at the last annual meeting of the Engineering Institute of Canada.

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range of temperature fluctuation *en route* to destination, often as much as 35 deg. C. If the temperature drops below the brittle point, the coating may crack off; and if the solar heat absorbed raises the temperature of the coating above the melting point, the mixture runs, in addition to which there is always a certain amount of damage due to abrasion in handling, all of which necessitates careful inspection and attention to repairs. Coal tar pitch, when properly refined, makes one of the best preservative dips, but, unfortunately, the range between the brittle and melting points of this material rarely exceeds 25 deg. C., so an asphalt blend must be used in most cases where the pipe has to be shipped any distance after coating. Some of the asphalt mixtures which have been developed for this purpose have a temperature range (brittle point to melting point) of 48 or 55 deg. C., and have proved quite satisfactory in service. The absorption of solar heat may be limited considerably by dusting the surface of the pipe with Portland cement or fine white sand. A coating of whitewash applied over the sanded surface has been tried, and was found to keep the coating down to atmospheric temperature under a July sun.

Under some conditions the coating above described may be reinforced with advantage by a strip of fabric, 6 or 8 in. wide, wound spirally around the pipe while the coating is hot. This is easily done at the mill after the pipe has received the dip coat, by means of a machine designed for the purpose. The fabric should be dried in vacuum and saturated by passing through a small tank of the asphaltic mixture as it passes on to the pipe. Naturally, it is possible to make a better job with this type of coating in the mills while the pipe is clean and dry. A saturated fabric in rolls of suitable size would be convenient for this purpose in the field, such as a large-size electric tape, or the fabric may be saturated after application by a final coat of thin consistency. This method of protection has been used for some years, and has become standard with one American manufacturer for bell and spigot steel water pipe, having been found to give good service.

Protection Against Electrolysis.—Where the ditch is wet most of the time, especially where stray electric currents are likely to occur in the vicinity of the pipe, provision should be made to keep these stray currents off the pipe by the use of insulated joints or other means. The pipe should then be boxed in wood after being cleaned and having received the usual priming coat. The pipe is supported underneath, every 10 ft. or so, on some non-porous insulating material such as a piece of hard-burned sewer pipe or heavy glass, about ¾ in. thick. An asphaltic compound, such as "Parolyte," or some similar mixture with a melting point of about 65 deg. C., which has been heated so as to run readily, is poured between the pipe and the box on one side. Particular care should be taken that the asphalt passes underneath the pipe without leaving air pockets, which would, of course, leave an opening for water to penetrate the coating. This coating has been found to be very effective both against corrosion and electrolysis when applied uniformly and not less than ¾ in. thick. When the sides of the trench are stable, the side boards may be removed and the fill tamped in around the coating. However, it is better, as a rule, to leave the box undisturbed. This coating, together with insulated joints, affords good protection against electrolysis.

Where corrosive conditions are severe, as in marshy places where the water is brackish or acid, a covering of concrete has proved to give the best protection. A mixture of 3 of sand to 1 Portland cement, thoroughly mixed together, should be poured between the pipe and the box, as in the case of the bituminous coating. The pipe should be centred in the box and supported on non-porous material at suitable intervals, so that the coating will not be less than 2 in. in thickness for 8 or 12-in. line pipe. No priming coat is required, but the surface of the pipe should be well cleaned to remove all loose scale and dirt. The concrete should be moist enough to flow readily, and should finally be formed up over the top of the pipe to the required thickness. Precautions should be taken to avoid air pockets, with careful inspection to avoid leaving any uncoated places. Thorough mixing of the sand and cement ensures a waterproof concrete, and is better than to depend on introducing some waterproofing compound into the mixture. The side boards may be removed and re-used. If this is done, a coating of asphalt may be applied to the sides of the concrete before filling the ditch. A coat of hot asphalt should be applied to the bottom and sides of the box before the pipe is put into place. Forms made of thin corrugated steel sheets have been tried, and could probably be developed into a convenient and economical device where timber is scarce. Oil lines protected in this way in brackish water have been immune from corrosion for 25 years near the New Jersey coast. Precautions must be taken to guard against or repair cracking from expansion or contraction, or settlement. Concrete coatings are not proof against electrolysis.

The above includes what is believed to be the best type of coating of each class, although each situation will present problems of its own requiring special treatment as to details.

Internal Corrosion of Water Pipe.—The corrosion to which iron or steel pipes are subjected from contact with water on the inside is not so serious as external corrosion; on the other hand, it is somewhat more difficult to protect against.

The principal factors which determine the rate and character of internal corrosion and pitting are: (1) Composition and finish of the metal; and (2) composition, temperature and rate of flow of the water.

As in the case of external corrosion, the composition of the metal does not seem to have any marked influence on the character or amount of corrosion. Internal corrosion of cold-water pipes is usually so slow as to be negligible, although in some localities this is not the case. However, the rate of corrosion is usually so slow as to be difficult to determine with cold water, but when the water is heated under pressure the corrosive action is so much accelerated as to make it practicable to compare different materials in the same line and get trustworthy results in a year or two.

Effect of Mill Scale.

It has often been noticed that internal pitting is much deeper near mill scale where the scale is thick and firmly attached. The reason for this is undoubtedly due to the electro-negative character of the scale with respect to iron. Old rust acts somewhat in the same way, but is much less harmful. When the mill scale and rust are removed, the tendency to pitting is greatly reduced, provided the metal itself is fairly homogeneous and free from strains. It has been clearly demonstrated experimentally that surface finish is much more of a controlling factor in corrosion than any variation in composition of the metal in itself which is likely to occur, the explanation of this fact being that the external differences of potential due to mill scale and other extraneous matter is much greater than that due to segregation or other irregularities in the metal.

Corrosion varies directly with the temperature and rate of flow within certain limits, and also with the composition of the water. The higher the velocity, the more rapid is corrosion likely to be on unprotected metal.

Protection Against Internal Corrosion.

Under some conditions it is more economical to prevent internal corrosion by removing the dissolved oxygen from water. In fact, experience has shown that with hot water the latter method is much more effective and economical in the long run.

In practice the removal of oxygen from water has been accomplished in two ways:—(1) By mechanical de-aeration, for which there are two or three designs of apparatus in use giving satisfactory results. (2) The oxygen may be removed by chemical combination with some material such as scrap sheet iron.

Both the mechanical and chemical methods may be combined by using mechanical de-aeration to remove the larger portion of oxygen and the chemical treatment for residual oxygen.

The control of corrosion in condenser plants, especially where salt water is used, may be accomplished by de-aeration, and there are probably many other cases where this principle can be applied economically to engineering practice.

For the internal protection of mains under most conditions, a dip in a bath of well-refined asphalt

or coal tar will be sufficient. Again, the importance of thorough cleaning and the removal of all scale from the steel, so far as practicable, should be emphasised. Where the coating is applied in the field, a priming coat similar to that described for outside protection is necessary. Where the pipe is exposed to the weather for some time before laying, it is best to apply these coatings in the field just before laying the pipe in the ditch, as otherwise the variation in temperature and handling will tend to injure the coating. In any case, at least a priming coat should be applied to the clean surface of the mill.

Concrete has been used to a limited extent for the protection of the inside of pipes. Small service pipes have been used for thirty years in New England with an internal coating of $\frac{1}{8}$ in. of neat cement, applied by means of some simple appliances designed for the purpose. This coating has also shown great durability as a lining for steel or wrought-iron pipe carrying mine water, and when properly applied to the clean surface, about $\frac{3}{4}$ in. in thickness, it is quite difficult to break it off or injure it unless there is much variation in temperature.

The 11-ft. diameter steel pipe sections of the Catskill Aqueduct, were lined with 2 in. of portland cement grout. The plates of which the pipe was made were first pickled free from scale and given a coat of whitewash to prevent rusting. The outside of this pipe was protected by a coat of 1:3:5 concrete mixture, 4 in. thick at the top The reports from this line, which was put into service in 1915, indicate that this coating has been satisfactory so far as can be ascertained at present. It is interesting to find that the friction loss in the cement-lined Catskill conduits are less than in the unlined pipe under these conditions, notwithstanding the reduction in diameter of the lined pipe.

What has been written above necessarily deals in general principles. The details of the application of these principles to practice in various cases will of course require variation to suit local conditions. Considering the great economical importance of conservation of material in our day, it would seem that the boundaries of engineering practice should be broadened a little so as to include more of anti-corrosion engineering.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

The Quality of Pig Iron.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—There is one point in connection with pig-iron supplies which I think would be of general interest to your readers, namely, the very abnormal variation in the general analysis of pig-irons as made from six to twelve months ago compared with the last few months. Obviously, on account of the coal strike and the stoppage of the blast furnaces, a large amount of pig-iron has recently been supplied which has come from the last clearing-up of the pig stocks in hand; but, apart from this, there is a very wide variation in recent silicon contents of well-known brands compared with the same material supplied at the earlier date mentioned.

We find on examination of many hundreds of samples that twelve months ago the average silicon content of No. 3 foundry irons, as supplied, often reached the abnormal figure of 4 to 5.0 per cent. silicon, the pigs being exceptionally dirty and causing much trouble in usage. The silicon contents, just before the coal strike, of the same brands, had dropped to $2\frac{1}{2}$ to $3\frac{1}{2}$ per cent. The more we investigate the question of pig supplies the more the fact is impressed upon us of the necessity for better co-operation between the pig-makers and the foundry users, and unless some definite arrangement of sale by analysis instead of grading by fracture is in operation, and some definite understanding reached as to the analysis limits for various grades, the foundryman is far too much at the mercy of the pig suppliers. In our experience we find that it is the small users who suffer the most, and we are endeavouring ourselves to encourage even the smallest of shops to make use of systematic testing of pig-irons before using through the cupola.

It is unfortunate to find that a few well-known firms still persist in refusing to supply to analysis, even though very wide and ample limits are made for the various elements. It seems, in other words, that the foundryman has to take what he can get, and, unfortunately, there is still very great prejudice amongst many users of pig-iron against spending money on laboratory testing.

The importance of this matter to foundrymen is a much bigger point than is at present realised, in spite of many previous remarks on this subject. You will be doing a very great service to the foundry trade as a whole if attention is again very forcibly called to this matter in THE FOUNDRY TRADE JOURNAL.

We should certainly be very pleased to substantiate the evidence we have, and be highly delighted to take the matter up with any of the pig-iron suppliers at all interested. We are doing our utmost from our point of view to assist in the close co-operation in such matters and have no desire whatever to offer destructive criticism in any way.

If we are at all to gain headway in connection with the foundry practice, it is very certain that this and many other points will have to be given much greater consideration than at present.

We trust these few remarks will be of interest to you, and at any time we shall be very pleased to offer assistance in investigating any individual case that might be brought to your notice.—Yours, etc.,

W. C. POOLE.

The Keighley Laboratories,
South Street, Keighley,
June 27, 1921.

The Question of Apprenticeship.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—It was interesting to see in Mr. Vickers' letter to your JOURNAL that there is at last to be a real move forward in the training of foundry apprentices.

May I suggest that, in view of the pattern-maker being so inseparable from the foundry, that the apprentice to pattern-making be incorporated in the scheme?

Perhaps it would be no exaggeration to say that in this country one-third of our pattern-makers' apprentices serve their time in shops unattached to any foundry.

This means they lack the opportunity of following their work in the foundry, and for this reason a practical scheme, as outlined by Mr. Vickers, would be just the thing to complete the success of the capable and ambitious apprentice.

We are all acquainted with that type of pattern, that looks well, and testifies to the ability of the patternmaker in the use of his tools.

It may not, however, be practical, because the pattern-maker lacked the necessary foundry experience. It is essential that an apprentice to pattern-making should know as early as possible the principles of moulding so that he may start out at the very commencement on a sure foundation, upon which he can build up his reputation as a practical craftsman. The love of achievement and desire to forge ahead is the strongest in youth, and it is at this time the necessary encouragement should be given, not only for his own sake, but to produce a valuable asset to his country.—Yours, etc.,

J. R. MOORHOUSE.

15, Daimler Street, Alms Hill,
Manchester,
June 25, 1921.

WE regret to announce that Sir Gilbert Henry Claughton, Bart. has died at The Priory, Dudley, Worcestershire, in his sixty-sixth year. Created a baronet in 1912, Sir Gilbert was the chairman of the London and North-Western Railway, and was also on the directorates of nine other companies. For 20 years he acted as chief mineral agent to the Earl of Dudley, and to the end sat on the boards of the Earl of Dudley's Baggeridge Colliery, Limited, and the Earl of Dudley's Round Oak Works, Limited.

XUM

Reorganising a Foundry.

Perhaps some benefit might accrue from the study of an article, by Mr. Herbert R. Simonds, which recently appeared in the "Iron Trade Review," and describes how losses were changed to profits in an American iron foundry. This was accomplished by departmental re-arrangement, replacing old apparatus by more efficient equipment, encouraging the loyalty of employees, making adequate and useful records and giving improved services to customers.

Less than a year ago, the Arcade Malleable Iron Company, Worcester, Mass., was placed under new management, and since that time its production has been increasing constantly. Operation of the foundry at the time the management was changed was not considered encouraging, but the company gradually and systematically has been put back on its feet, and to-day, even during the general depression, it is still advancing, just having closed a contract for the purchase of a large adjoining plant which is to be converted into an additional foundry. This reorganisation and growth, which was hardly more than started before the business depression of last autumn set in, has continued throughout the winter.

The assumption on the part of the new management at the start was that a foundry should be run according to business principles. All foundry traditions were scrapped along with obsolete records and forms. In general, the chief distinction in the new system as compared with the old is the strict departmentalising of the plant's operation. In the new scheme each department is placed under a chief responsible for certain definite operations. Thus, the core-making department is charged with the economical manufacture of cores and a cost system has been worked out which enables the core-room foreman to tell what his cores are costing. He is in effect an independent manufacturer, buying his raw material and selling his finished product.

A similar arrangement applies to every other department. The only exception to the rule that each department must show a profit is the office department. In this case, the expense is divided amongst the other departments and becomes part of their individual expenses. The value of decentralisation comes principally through the rivalry and competition which is set up between the different departmental heads, but it also furnishes the best possible means for a plant manager to tell where his greatest profit lies and where conditions are in need of improvement.

To derive the full benefit of any scheme of departments, it is necessary to have what first appears to be an elaborate system of records and paper work. Had the reorganisation been limited to paper work alone, it most certainly would not have succeeded. Successful record keeping is merely a means to an end and not the end in itself. In the ideal case, it is cut down to the fewest possible operations which will give the information required. The manager states what information he will require, and the system expert studies and works to secure this information with the least amount of effort. Adequate and correct records are necessary to the successful operation of a business, but successful operation is dependent upon many other factors.

When the new manager was appointed, he was first impressed by the dark griminess of everything including the offices. The shop superintendent had his office in a little hole over the foundry floor. The clerical office was crowded into a small dark room near the foundry, where the dust and noise furnished a continual disturbance. Even the foundry floor was not conveniently arranged. Moulders had insufficient light in many cases, and the methods of distributing metals and sand were out of date. Moulding machines, overhead rails, systems of sand distribution and proper light are common to the majority of foundries to-day. Plant features outside of the foundry floor are apt to be given less attention.

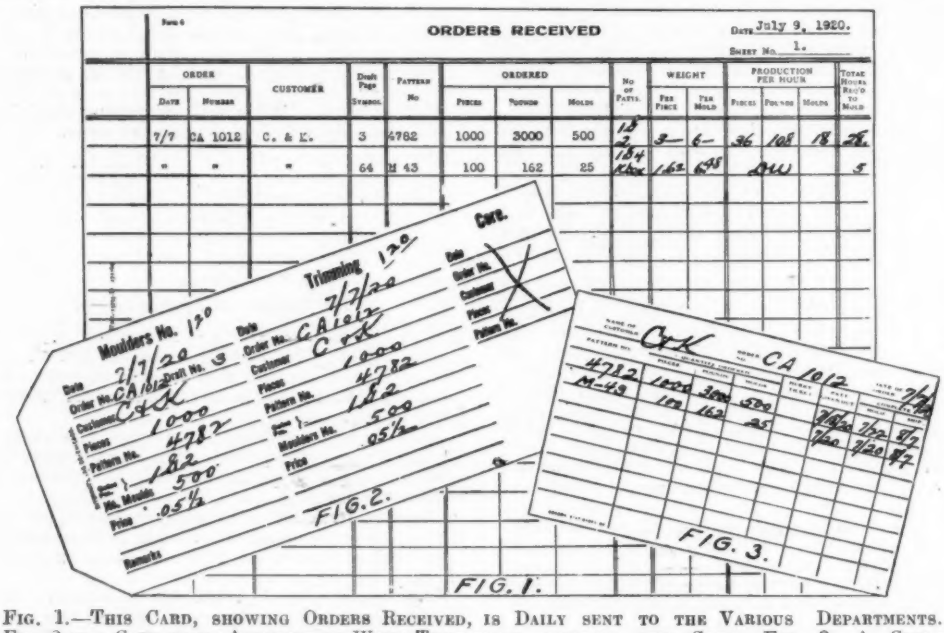

FIG. 1.—THIS CARD, SHOWING ORDERS RECEIVED, IS DAILY SENT TO THE VARIOUS DEPARTMENTS. FIG. 2 IS A CARD TO BE ATTACHED TO WORK TRAVELLING THROUGH THE SHOP. FIG. 3.—A CROSS REFERENCE CARD INDICATING THE CUSTOMER'S ORDER NO.

One of the first changes was to give the foundry superintendent and his assistant a large roomy office equipped with recording pyrometers and other apparatus. This office is large enough so that schools may be held in part of it, and classes along definite lines are part of the present scheme of operation. Early in the reorganisation the main office was moved to a room which formerly had been used for pattern storage but which now is completely overhauled and refurnished to provide a modern, well lighted, attractive office with private rooms for the principal department heads.

The stock in trade of a jobbing foundry such as this plant is its customers' patterns. Realising this, the new management reorganised the entire pattern department on a businesslike basis. First, a new room was found which could be devoted to pattern storage. This was equipped with suitable shelves, and after destroying all obsolete patterns, the remainder were card indexed and filed on the shelves according to customer's name and pattern number, subdivisions being used wherever neces-

sary. One man in charge of the pattern storage department is responsible for the patterns. He must know from his card index whether a pattern is on his shelves, is in the foundry, or has been sent to the owner. This requires that a definite system of records be kept.

In the pattern department a book is kept in which sketches are made of each pattern as it is received. These sketches are made under the customer's name so that at any time a foreman may look in this sketch book and pick out any pattern belonging to a particular customer. This sketch book is really a check on the card index.

To illustrate the extent of the pattern end of the foundry industry, in the plant being considered, it may be stated that one customer alone has over 5,000 patterns on the shelves of the storage room.

Like the pattern room, each other department has been the subject of individual study, and has been rearranged to secure increased efficiency. Thus the core room was moved from the foundry floor to an intermediate floor at one end of the foundry with an opening directly on to a railway siding.

use of a double shift of labourers on the foundry floor. Ordinarily in a foundry, a comparatively large force of helpers is required during pouring, and it is sometimes difficult during the rest of the day to find profitable labour for this entire force. The double shift overcomes most of this trouble. By having a small force of approximately half the usual size during the day and another force of the same size at night, with the two shifts overlapping during the pouring period, the full number of men are available when they are needed, and the night force is able to put in very effective work in cleaning up and preparing the foundry for the following day. The theory is that any work which a helper can do to relieve a moulder is so much money saved. The double shift is now working successfully with all men satisfied, particularly the moulders, who come to work in the morning and find everything in complete readiness for them to start moulding.

The plant manager in his reorganisation has had uppermost in his mind the theory that the good will of his men is his biggest asset. Therefore, he has given a great deal of attention to

Form 1

Crompton & Knowles Loom Works. Draft Page 3 Pattern No. 4782

No. of Patts. Weight per Mold Weight per Pc. Plain Cored

	Order No	Date of Order	Price per Pound	Requirements: Molds	Pieces	Pounds	Shipped Complete	Quotation: Number	Date	Remarks
○	Ca 1012	7/7/20	48	500	1000	3000	8/7/20	6075	7/5/20	

Form 2

Crompton & Knowles Loom Works. Draft Page 3 Pattern No. 4782

	Order No	Date of Order	Instructions	Complete: Date	Quantity	Requirements: Pieces	Pounds	Shipments
○	Ca 1012	7/7/20		7/22	1012	1000	3000	Date 8/2 8/7 Balance 3000 - 1259 Shipped 1741 1291

Form 3

Crompton & Knowles Loom Works. Draft Page 3 Pattern No. 4782

	Order No	Date of Order	In Sand Molder	Complete	Molds	Requirements: Pieces	Pounds	Production
○	Ca 1012	7/7/20	7/16/20 120	7/22	500	1000	3000	Pieces 237 292 289 144 Date 7/19 7/20 7/21 7/22 Pounds Pieces Date Pounds
○	Ca 2187	4/4/21	4/15/21 102		250	500	1500	
○								Pounds Pieces Date Pounds Pieces Date Pounds

FIG. 4.—ILLUSTRATING THREE OF THE FOUR SHEETS SENT TO THE PRODUCTION DEPARTMENT ON RECEIPT OF ORDERS, THE FOURTH FORM BEING IDENTICAL WITH THE FIRST SHOWN.

A sand storage room was built to include this opening, and next to this storage room a mixing room was placed. Previous to this, the mixer had been in a dark corner in one end of the foundry proper.

Even after the rearrangement, cores were found to be costing too much. A good portion of the cores which were turned out were found to be small and of relatively simple construction, and this fact suggested the idea of introducing girl core-makers into the core department. After some initial difficulties, this was accomplished, and to-day in a separate room adjacent to the main core room there is a girls' department which is successfully contributing its part towards the production of the plant, and as a result, core costs have dropped materially. The girls' pay is much less than that of the men, and in some cases their speed is far greater. These girls enter through a private doorway, separate from the rest of the plant, and their department is provided with a modern, well-equipped rest room. A wall-opening with a shelf makes it possible for them to deliver their completed cores to the oven attendant without necessity for leaving their department. Another labour economy has been effected by the

the personnel side of the business. During the recent scarcity of some food products, a supply of several commodities was laid in and sold to the employees at cost. This work has gradually grown until to-day a sort of co-operative store operates where employees or their families may get nearly all their groceries.

Last autumn the plant began serving hot coffee to the men at noon, and this move was so enthusiastically received that the idea was enlarged, and to-day a midday lunch counter is operated immediately adjacent to the main foundry room. The principal objection to lunch rooms in foundries has been that the moulders with their dirty clothes and hands are reluctant to go into any sort of a room where they must sit down or eat at a table, and because of lack of time they do not like to stop long to clean up. The result is that in many foundries where more or less elaborate lunch rooms are operated, a large number of moulders may be seen each noon at the place of their work eating lunches which they have brought from home.

At the Arcade plant, the lunch room at one end of the foundry is so handy that the men usually leave their work, secure the things they want, and return to eat wherever they desire in the foundry

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room. The success of the enterprise is shown by its patronage. Fully 90 per cent. of the foundry workers take advantage of the service each day. The food, which is of attractive variety, is sold as near to cost as possible.

Improvements and alterations of the mechanical plant come under the heading of labour-saving equipment. A new annealing furnace was built to secure greater capacity and increased firing efficiency. The old type of truck used in charging the various furnaces was replaced by a pneumatic truck. This truck, operated by one man, places a tier of five annealing boxes where hertofore six men were required to place a four-box tier. In the dispatch department an old type of scales was replaced by a direct reading type which cut down the time of weighing considerably.

Automatic sorters for certain classes of castings now are being considered as an additional feature. A motor truck delivery system has been installed as a separate department which makes a definite charge to customers for the service rendered. This department has proved a big convenience to customers, and also is a paying proposition.

In order to take advantage of efficient equipment and manufacturing methods, it is necessary to have an adequate system of records in the office. Pertern equipment, and other similar items. One copy is kept in the pattern safe and is used in making out operation tickets as shown in Fig. 2. The third copy is sent to the shipping department, and the fourth to the sales department.

The arrival of these copies of the "Orders Received" sheets is the signal for each department head to remove sheets as shown in Fig. 4, which are on file, and send them to the production department. The dispatch department, for instance, removes a pink sheet for each pattern number from its file of shipping order pink sheets. At the production department these are filled in and returned. A similar procedure takes place at the other departments. In the sales department, white sheets are removed for each pattern number appearing on the "Orders Received" sheets. These are then filled in at the production department and returned. The different departments have different coloured sheets, so that after the "Orders Received" sheet is sent out, the blue, pink, yellow and white sheets of Fig. 4 are assembled in the production department. Here the orders are entered, and each sheet as described is sent back to its proper department.

These departmental records form the backbone of the entire office system. The production depart-

	NO. PIECES GOOD	POUNDS GOOD	POUNDS POOR	POUNDS % POOR	OTHER COSTS		GRAND TOTAL COST	COST PER POUND	POUNDS PER HOUR	REMARKS
1										
2										
3	1437	278	31	9.7%	44.72		90.33	.3231	10 1	
4										

Customer C & K Patt. No. 1847-A

	COST PERIOD	MOLDING NO. HOURS	DIRECT LABOR	BURDEN	TOTAL COST	CORES NO. CORES	NO. HOURS	DIRECT LABOR	BURDEN	TOTAL COST
1										
2										
3		27 6	21 46	14 62	36 08	1000	62	5 16	4 37	9 53
4										
12										
13										

FIG. 5.—THE FRONT AND BACK OF COST CARD, FILLED IN FROM THE TIMEKEEPER'S RECORDS.

haps no part of a foundry has been subjected to so much criticism as the office, and even to-day many successful and long-established foundries in New England are running with practically no office work or records, and are proud of this fact.

The question as to the extent of the paper work in connection with a foundry is one of considerable difference of opinion, and the intention here merely is to show briefly what the present practice is at the Arcade plant. Formerly, all records were kept on an order number system. Each order as it came to the plant was given a consecutive number, which thus became the work order and the index of the records. This was found to be awkward to use, as it either necessitated a cross index or running through long lists of names in an attempt to locate the exact filing number of the desired order.

At present all records are filed alphabetically according to customer's name and pattern number. Orders when received go direct to the sales department for its O.K. They then go to the production department, where "Orders Received" sheets, as shown in Fig. 1, are made out in four copies. These are distributed as follows:—The first and second copies are sent to the pattern safe where data is entered concerning each individual pattern, that is, the page number where the pattern appears in the sketch book, the pattment, through the receipt from the other departments of the form as described, is able to determine whether the pattern equipment is on hand, whether the price is correct, and whether provision has been made for other factors bearing upon the production of the castings. The production departments is now in a position to acknowledge the orders, and to write for additional patterns, if needed.

Inasmuch as all records are filed by pattern numbers, a cross index is kept by customer's order number. This is shown in Fig. 3.

On all forms the data entered has been carefully studied and all unessential elements have been eliminated. Formerly, it was the custom to enter orders as "so many pieces" which gave no indication of the size of the order, the amount of material required, or the length of time to complete. Now the weight is given, both per piece and per mould, and this furnishes a ready means of estimating production and cost.

The operation tag, as shown in Fig. 2, is divided into three parts, one of which goes to the core department, one to the trimming department, and one is attached to the patterns themselves when they go out on to the foundry floor. These tags follow the work, and are the actual authority to the men on the job.

Costs are kept independent of the order system

and independent of the workers themselves. A time-keeper makes the rounds, and fills in records which show what men are working on different jobs. From these time-keeper's records, cost cards as shown in Fig. 5 are filled out. Here again it is seen that the customer's name comes first and furnishes the method of filing. The detail of costs is kept on cards of the form shown in Fig. 6. A

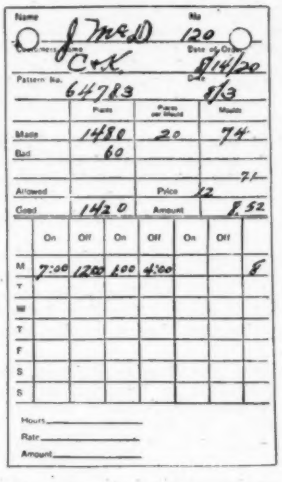


FIG. 6.—THE TIMEKEEPER'S DAILY RECORD.

card such as this is made out each day for each pattern. It carries the name of the moulders or workers, the customer's name, and the pattern number, together with information concerning the pieces and moulds completed. The work of the moulders is usually on a piece-rate basis, and in such cases the price per piece is entered directly.

Nearly all foundries are called upon to make estimates for prospective work, and unless some system of records of these estimates is maintained, much of the work of estimating will have to be duplicated, and there is also the danger of discrepancy between the first and second estimate covering the same work.

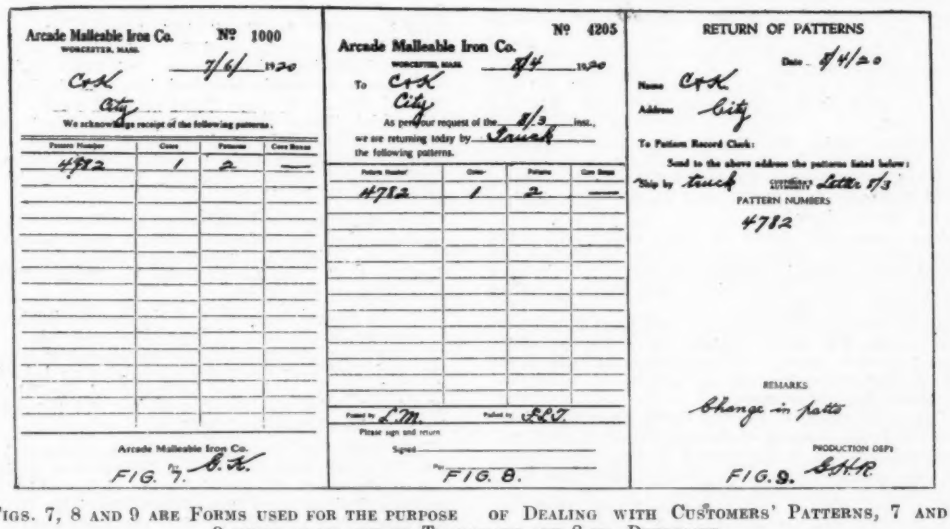
making the estimate and the date of making the quotation. In case the patterns must be made up for the job, the cost of these and of the core-boxes is included on this form.

Nearly all jobbing foundries have had difficulty occasionally in connection with pattern records. When a pattern cannot be found, foundrymen are apt to claim that it was sent home, but it is the exception for this claim to be backed up by a receipt. The pattern records of the plant are designed to guard against this and other difficulties. As soon as a pattern is received the form shown in Fig. 7 is made out in triplicate. One form goes to the sales department, where it is checked over to see if some order is waiting for this particular arrival. It then goes to the production department, where it is also checked. The second copy goes to the foundry superintendent for his information, and the third copy goes to the customer as a receipt.

When the return of patterns to a customer is requested, the form shown in Fig. 8 is made out, giving a list of the pattern numbers and other data and is posted to the customer, who signs and returns it If there is delay, this particular form is followed up by a letter asking for acknowledgment of receipt of patterns. Instructions given to the pattern storage department for the return of patterns are made out on forms shown in Fig. 9.

A perpetual record of patterns is kept on a form which contains the customer's name and the pattern number of each pattern, in addition to information as to the position of the pattern. This card also gives a complete record of the patterns received, the material of which they are made, the number of gates, the number of core-boxes, the number of patterns and core-boxes made at the foundry, and information concerning receipts and deliveries of patterns and core-boxes. In addition to this, prices are listed per 100 moulds and per 100 cores.

At first glance these records seem to embody some duplication, but the advantage of having information as to prices and position of patterns and core-boxes has proved sufficiently valuable to warrant keeping up the present system. If a customer telephones to ascertain how the work on his order is progressing, it is desirable to be able to tell him that his pattern is on the foundry floor, that a certain number of moulds have been made, and that deliveries will start with a reason-



FIGS. 7, 8 AND 9 ARE FORMS USED FOR THE PURPOSE OF DEALING WITH CUSTOMERS' PATTERNS, 7 AND 9 BEING MADE OUT IN TRIPLICATE AND 8 IN DUPLICATE.

When a customer writes in for an estimate, the first step is to look up former estimates made for this same customer, and from these to determine whether the cost of the new work has already been covered on some former estimate, or whether it will be necessary to make out an entirely new estimate. Many times the data on the old estimates, while not directly applicable to the new work, forms valuable assistance in checking the new figures and costs. A standard form is used for preparing estimates. The customer's name comes first. At the right-hand side are entered the date of

able degree of certainty within ten days, for example.

When it is considered that orders often are contingent upon the presence of patterns, the value of a system sufficiently extensive to protect a foundry against loss or misplacement of these patterns is readily seen. The forms shown are the principal ones in the office system of the Arcade Malleable Iron Company's plant. These have formed an important part of the work of reorganisation, but all records are dependent for their success upon the co-operation in other departments.

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Trade Talk.

JOHN LYSAGHT, LIMITED, have removed their London offices to Imrie House, 33-36, King William Street, E.C.4.

MESSRS. C. H. W. MITCHELL & COMPANY, engineers, 37, Cadogan Street, Glasgow, have removed to 142, West Regent Street, Glasgow.

A GREAVES-ETCHELLS electric furnace of a capacity of one ton is being erected at the works of the Apex Steel Company, Limited, Sheffield.

IN common with members of the engineering trades, 400 brass and metal mechanics employed by the four Rotherham brass works ceased work last week.

FRESH TENDERS, closing October 19, are invited by the Victorian Railways Department for the supply of an electrical furnace for the Newport workshops.

THE ALLIED NATIONAL CORPORATION, LIMITED, engineers, 34, Great Tower Street, London, E.C.3, have removed to 72-74, Victoria Street, London, S.W.1.

GEORGE H. ALEXANDER MACHINERY, LIMITED, have removed from 62, Broadway, Westminster, S.W.1, to 76, Petty France—late York Street—Westminster, S.W.1.

ROSE, DOWNS & THOMPSON, LIMITED, and Rose, Downs & Thompson (Far East), Limited, have removed to 28, Victoria Street, Westminster, London, S.W.1.

INDIAN MANGANESE ORE EXPORTS during the nine months ended December 31, 1920, aggregated 575,492 tons as compared with 246,184 tons in the corresponding period in 1919.

THE Federation of Iron and Steel Manufacturers estimates that while in January 79.9 per cent. of the workers were employed in the trade, in May this figure had dropped to 14.2 per cent.

THE June report of the Amalgamated Engineering Union states that at the end of May the total number of men unemployed was 112,319, or an increase of 32,208 over the preceding month.

A CONTRACT for 10,000 tons of steel rails for the Australian Government has gone to the Continent, British firms having quoted prices considerably above those of German and Belgian makers.

STATISTICS compiled by the U.S. Geological Survey show that the production of primary metallic zinc from foreign and domestic ores in 1920 amounted to 463,000 tons, as compared with 465,743 tons in 1919.

THE FLEET AUXILIARY "OLNA," an oil carrier of 10,000 tons capacity, was launched at Devonport Dockyard last week. A similar vessel is under construction at Pembroke. Both are constructed on the Isherwood system.

MESSRS. WILLIAMS & WOMERSLEY, who have acquired the goodwill of the power transmission department of the business of Messrs. A. G. Barrett & Company, The Forge, Bradford, have removed to the Ings Foundry, Wakefield.

THE Chinese Government has notified the provincial Governments that the Tayeh Iron Works has been exempted from export tax on iron and steel and also for a period of five years from provincial likin and other duties.

LICENCES under the Non-Ferrous Metal Industry Act, 1918, have been granted to Derby & Company, Limited, 37-38, Hatton Garden, E.C.1; R. C. Griffiths, 14-20, St. Mary Axe, E.C.3; and W. J. Onions, 3, New Street, Birmingham.

As a result, it is stated, of notice having been given of a reduction in wages, some 200 or 300 casters employed in the Walsall malleable ironfoundry trade have come out on strike. So far the trouble appears to affect only two firms in the town.

BRUCE PEEBLES & COMPANY, LIMITED, of Edinburgh, have prepared a very complete set of lantern slides regarding their works and manufactures, and these are available for illustrating lectures on electrical machinery in this country.

THE COMMERCIAL ENGINEERING COMPANY, have purchased the business of JOSEPH COOKE & SON, and equipped a works in Commercial Street, Birmingham, for the manufacture of the Cooke miners' oil lamp and complete lamp room fittings.

IT is expected, says the Central News, that the United States Steel Corporation will cut the prices of many of its steel products in the next fortnight. The Corporation is also expected to eliminate payment of time and a half for overtime work.

THE Institution of Heating and Ventilating Engineers (Incorporated) held its summer meeting at Sheffield, the delegates being welcomed by Mr. Frank Biggin (of the Brightside Foundry and Engineering Company), who is the national president.

SIX UNIONS in the light metal trades have balloted on acceptance or rejection of a wage reduction of 3s. per week for time workers, and 7½ per cent. in the case of piece workers, from July 4, with similar reductions on August 1. About 20,000 men are affected, and less than 50 per cent. have voted, the result of the ballot being:—For accepting the reductions, 4,219; against, 3,201; majority, 1,018.

THE steamer "St. Rene," built by Messrs. William Gray & Company (1918), Limited, West Hartlepool, for the Société Navale de l'Ouest, Paris, has had the official trial trip. The vessel is 362 ft. long, with a deadweight carrying capacity of over 6,900 tons.

SIR F. GORE-BROWNE, K.C., presiding at a meeting of the Railway Rates Advisory Committee of the Ministry of Transport, held at the Old Hall, Lincoln's Inn, said a Railway Rates Tribunal was to be constituted under the Railways Bill now before Parliament.

THE COMMERCIAL SECRETARY TO H.M. LEGATION AT BUENOS AIRES cables that tenders will shortly be invited by the Board of Sanitary Works of the Nation (Direccion General de Obras Sanitarias de la Nacion) at Buenos Aires for the supply of 7,000 tons of cast iron pipes.

THE Central Wages Board for the Railways will, it is understood, as the result of a meeting last week, recommend to the Ministry of Transport that a reduction of 5s. a week be made under the wages sliding scale in view of the fall in the cost of living to 119 points.

A TENDER FOR PIPES, BENDS and special castings has been placed by the Sheffield Water Committee with the Société Anonymec des Hauts-Fourneaux et Fonderies de Pont-à-Mousson. The French tender was for £719, while the next lowest tender was for nearly £600 more.

M. LOMANSOW, the Russian Railway Commissioner, who has recently been in Prague, has announced that the Soviet Government is about to place orders for 2,700 locomotives in the United States, while 2,000 will also be ordered in Britain, Germany, Denmark, and Sweden.

ON the occasion of his forthcoming visit to Yorkshire, the Prince of Wales will spend July 19 at Sheffield. The next day, after opening the new super-power station at Rotherham, the Prince will arrive at Harewood House, Leeds, on a visit to the Earl of Harewood.

AT the annual meeting of Messrs. William Foster & Company, Limited, held at Lincoln, the chairman said the outlook in the engineering trade was black indeed. Sir William Tritton said the firm had had to forego contracts of £300,000. One was baulked by the men and the other by the Government.

THE SOCIETE DES MINES D'OUDJDA have entered into an agreement with the Compagnie Royale Asturienne under which the former Company will be allowed to mine manganese ore on certain property of the Asturienne, paying a royalty of one franc per ton of ore exported or treated on the spot.

SOPHUS BERENDSEN (LONDON), LTD., 43-45, Great Tower Street, E.C.3, have removed to 10, Philpot Lane, E.C. The company have been appointed agents in this country for the Société Anonyme Compagnie Générale des Conduites d'Eau, of Liège, manufacturers of cast-iron pipes for gas and water mains.

THERE was recently launched from the shipbuilding yard of Messrs. William Hamilton & Company, Limited, shipbuilders, Port Glasgow, the steel screw steamer "Era," built to the order of Messrs Howard Smith, Limited, for their Australian trade. The principal dimensions are:— Length, 343 ft.; breadth, 49 ft.; depth, 24 ft. 3½ in.

THE BIRMINGHAM METALLURGICAL SOCIETY (INC.) announce that the registered office is now Chamber of Commerce Buildings, New Street, Birmingham, and that Mr. A. C. Craig has succeeded Mr. Thomas Vickers as secretary of the Society.

AT the annual inspection of the National Physical Laboratory by the General Board last week, there was an interesting ceremony, Sir Joseph Thomson presenting, and Professor Sherrington receiving on behalf of the Laboratory, a bronze bas-relief of Sir Richard Glazebrook, who was the Director of the Laboratory from its foundation until 1919.

THE DIRECTORS OF THE STANTON IRONWORKS COMPANY, LIMITED, announce that reference was made in last year's report to manufacturing rights which the company had acquired from International De Lavaud Manufacturing Corporation for the manufacture of iron pipes centrifugally. Material progress has been made with the extensive works which they are erecting at Stanton for the manufacture of pipes under this process, and before the end of the year the pipe will be on the market.

A GENERAL MEETING of the Institution of Production Engineers will be held at the Institution of Mechanical Engineers, Storey's Gate, S.W.1, on Friday, July 15, at 7.30 p.m., when all those who are interested in matters appertaining to production are invited to attend. At the meeting, Mr. Max Lawrence, M.I.M.E., M.I.A.E., will deliver a paper on "Production and the Engineer." The proposed activities of the Institution during the coming winter session will be outlined, and announcements will be made with regard to the election of various grades of members.

Electric Furnaces for Non-Ferrous Metals.*

By H. W. Gillett.

In selecting a furnace for service in non-ferrous melting three things have to be considered: The characteristics of the alloys to be melted; the characteristics of the furnace; and the nature of the work, *i.e.*, the tonnage desired, the number of hours per day the furnace is to work, and whether various alloys are to be melted in the same furnace.

The main important characteristics of brass from the point of view of electric melting are the volatility of the zinc contained in it and the rate of heat conduction through the molten brass. If heat is supplied from above at a more rapid rate than it can be conducted through the melt, overheating of the surface layer ensues and the loss of zinc becomes prohibitive. Hence, electric furnaces of the direct or indirect arc types used for steel are not applicable to a brass high in zinc. The ordinary horizontal-ring induction furnace is not applicable because of "pinch" troubles due to the high electrical conductivity of the alloy. Alloys that approach steel in their nature rather than brass, for example, the non-volatile nickel alloys, such as nichrome and monel metal, can be, and are, successfully melted in ordinary direct arc furnaces used for steel, like the Heroult, Greaves-Etchells, and Snyder. Nichrome can be handled in the ordinary induction furnace. True bronzes can be melted by a direct arc. Direct-arc furnaces of the roof-opening type allow rapid charging and are favoured in one installation on bronze where rapid production is the chief aim.

Pure copper ought to be capable of being melted with a direct arc, but according to Hansen's experience doing so caused volatilisation of copper and copper poisoning of the workmen. It is probable that this trouble, or the lack of it, depends again on the relative rate at which heat is supplied and that at which it is conducted through the melt. A high-powered arc in contact with the charge evidently causes some volatilisation of copper. Less severe and less local heating is obtained in indirect arc furnaces. The U.S. Mint has had great success on coinage nickel, bronze, and silver with Rennerfelt indirect arc furnaces.

Silver is slightly volatile, and a direct arc-type furnace would hardly be applicable. The indirect arc-type furnace is, the U.S. Mint having melted 3,000,000 lbs. of silver dollars with a metal loss of 0.01 per cent.

The new Von Schlegell repelling arc furnace, which may be operated either as a direct or an indirect current furnace, is being applied to non-ferrous melting. If the self-starting and automatic regulating scheme proves mechanically and electrically feasible, this furnace may be of value on those alloys that can be melted in direct or stationary indirect-arc furnaces.

When it is a question of common red brasses, which contain, say, 5 per cent. zinc, the direct arc is not suitable, and at about 20 per cent. zinc the stationary indirect arc also proves unsatisfactory. When the important yellow brasses of 30 to 40 per cent. zinc or nickel brasses are to be considered, we are forced to abandon the standard steel furnace types and strike out on new paths. This necessity has been the mother of a number of interesting and ingenious methods of avoiding the difficulty.

Three general methods have been followed:—

Using a low rate of power input.

Using a high rate of power input, and stirring by moving the furnace.

Heating from within the metal itself, with inherent stirring.

A low rate of power input means low efficiency and low production. When the heat is mainly indirectly transmitted from the source to the charge by reflection from the roof in order to distribute it more evenly, refractory problems are made rather difficult. Various furnace builders attack the problem with furnaces of this general type in different ways.

Bennett builds his furnace like a regular three-phase direct-arc furnace, but holds the voltage down so that he gets contact resistance rather than true arcs, and by holding down the rate of power input, allows time for equalisation of temperature and avoidance of local superheating. By generating the heat close to the charge he avoids much of the thermal loss found with other low-powered types.

The largest electric brass furnace in use is of this type, though it has not been introduced into the industry outside the plant of the inventor.

Baily uses a large, relatively low temperature source of heat, a single-phase granular resistor, and still further distributes the heat by reflecting the bulk of it from the roof. A low rate of power input is used, partly on account of the limitations due to the resistor troughs, and a furnace results which is slow, giving low production, sluggish, with a high heat storage and of low thermal efficiency, especially when not run continuously. However, the furnace is simple and easy to operate, and for this reason has had a large measure of success.

The furnace made by the General Electric Company applies heat in much the same manner as the Baily furnace, but by using the smothered-arc or contact-resistance principle, it can use a higher rate of power input, gaining somewhat in thermal efficiency, but increasing the difficulties with the refractories due to the higher temperature of the heat source. Three-phase power can be used instead of single-phase. Considering the time it has been on the market, it has found relatively little use.

The Rennerfelt electric reverberatory furnace is just like the General Electric furnace in its source of heat, but locates this in the middle of the furnace instead of around the sides, and consequently wastes less energy in heating the furnace walls instead of the charge. One small furnace of this type has shown promising results. If structural difficulties do not become too great in larger furnaces, it should find considerable use.

The next method of avoiding the specific difficulties found with alloys high in zinc is to use an indirect-arc furnace, with a high rate of power input to get thermal efficiency, and to move the furnace so as to stir the metal and avoid superheating the surface. This was done long ago by Stassano in the early days of electric steel, but such furnaces were not then applied to brass. The principal applications of this method are the Detroit rocking furnace (operating under licence from the Bureau of Mines) and the Booth rotating furnace, the former being installed almost wholly in the one-ton size, and the latter almost wholly in 500-lb. or even smaller sizes. These furnaces give good efficiency, even on an eight-hour day, and have been adopted by the industry with remarkable rapidity. They are capable (especially the Detroit, which can be mechanically charged from overhead) of rapid operation and high production.

A similar furnace, the American, has been introduced by Ryan, but only one installation has yet been made. All these furnaces are single phase.

A polyphase furnace, the Moore Rapid 'Lectromelt, is stated to fall into the moving-indirect-arc class, but nothing more than experimental operation has as yet been credited to this furnace and its details are still shrouded in mystery. The old gyrating Stassano furnace has very recently been resurrected at the hands of the Volta Manufacturing Company, provided with a simpler gyratory mechanism, re-named the Volta, and applied to brass. One of these furnaces has been tried experimentally in a foundry for a short while, but little data are yet available, so the adequacy of the stirring is not yet known. It has the advantages of three-phase operation, but lacks the ability of the rocking type to take up heat from the roof into the melt.

One other possibility deserves mention, though it is not yet in use. The rocking, rotating, or gyrating Thomson-Fitzgerald design has a solid slotted resistor as the source of heat, and the fur-

* Extracted from paper read before a recent meeting of the American Electro-Chemical Society. The author is connected with the United States Bureau of Mines, Ithaca, N.Y.

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nace is moved to stir the charge. As not even the aspirations of the inventors have yet been publicly voiced, though the furnace was once advertised for sale, and data on its performance are lacking, further discussion is not called for here.

The third method deals with meeting the idiosyncrasies of brass. Hering's work on the pinch effect was the starting point for those furnaces which use the metal itself as resistor and by virtue of various electromagnetic effects, such as the pinch effect and the motor effect, cause circulation of the metal. The Hering furnace was tried on brass on a considerable scale but is no longer in use. Hering has a plan for overcoming the difficulties with the metallic electrodes.

Foley has made large-scale experiments on a vertical-ring induction furnace in which the hydrostatic head of the molten metal opposes the pinch force, but at last reports his furnace is not in the commercial stage.

TABLE I.—*Showing the number of furnaces installed in the United States.*

Make.	Total capacity per heat tons.	Total kilowatt	Number furnaces.	Number users.
Ajax-Wyatt ..	45	4,635	93	25
Detroit rocking ..	53	15,900	57	28
Baily	48	6,890	76	51
Booth	13	5,345	40	35
Other furnaces ..	34	9,580	52	30
Total in use ..	193	42,350	318	169

The Ajax-Wyatt vertical-ring induction furnace, with its internal heating in the metal itself, its automatic circulation, and its compact form, has shown astonishing thermal efficiency and has been adopted generally by those brass rolling-mill industries which can readily melt 24 hours a day and need not often change a furnace from one alloy to another—conditions vital to the successful operation of this furnace. As these conditions are seldom found in the foundry, as differentiated from the rolling mill, it has had little foundry use. It is, in general, not applicable to alloys of high electrical conductivity, i.e., those high in copper.

The last type that deserves mention is the ingenious high-frequency eddy-current Ajax-Northrup furnace. This is in commercial use on silver, platinum, etc., and besides the commercial installations some 25 furnaces are being used in laboratories on account of their extreme flexibility.

The furnace itself is highly successful for its special applications, and may be expected to find large commercial use if and when the generation of the necessary high-frequency current is so developed and cheapened that normal sized Ajax Northrup furnaces are practical.

It appears that with this array of furnaces any brass melter can find an electric furnace of at least fairly well-proved ability, to handle his work, as there are many types and many sizes of most types. If he cannot use a single-phase furnace owing to limitations of his power supply, he can probably find a three-phase type that will serve. As a matter of fact, the furnace in widest use, the Ajax-Wyatt, Baily, Booth and Detroit, are all single-phase.

If the furnace is chosen so as to be metallurgically fit for its work, for example, if a direct-arc or a stationary indirect-arc furnace on yellow brass is avoided, and if they are run closed when melting yellow brass, so that zinc vapour does not escape, all the furnaces show marked savings in metal losses. Labour costs are low, as the furnaces either require little attendance or can be supplied with automatic control, and the writer believes they will be increasingly so supplied.

Power costs are a function of the price of power, the continuity of use of the furnace, and of the thermal efficiency of the furnace. At war-time prices for fuel electric melting was cheaper on nearly all non-ferrous alloys in nearly all locations, with almost any electric furnace. With fuel prices nearer normal the innate thermal efficiency of the furnace and the operation of a given furnace as nearly continuously and with as few delays as possible, so as to develop the highest possible thermal efficiency, will become increasingly important

When the electric furnace replaces crucible furnaces it effects a large saving in that item. In calculating the savings possible by electric melting, one should not forget, as some electric furnace salesmen are prone to do, that the electric is high in first cost and that interests, depreciation and obsolescence charges cannot be disregarded. These charges, per ton, are minimised by operation that gives maximum production, i.e., steady operation on 24- or 16-hour schedules instead of 8 or 10, cutting down delays in time of pouring and charging, and keeping up to the maximum allowable rate of power input.

The most important of all points about any furnace, its ability to produce metal of the desired quality, has not been mentioned, because without it no furnace can be used.

It is doubtful if the electric furnace has produced any better brass than the best from the old crucible in a pit-fire, but due to the larger melts and the stirring produced by some furnace types, electric brass is probably more homogeneous and more uniformly good than that from fuel-fired furnaces.

The number of furnaces in use in the United States are given in Table I., and is sufficient proof that the electric brass furnace gives a good quality of product. This same list, better than any other evidence, proves, too, that electric melting of non-ferrous alloys is commercially economical.

The electric brass furnace to-day occupies a position of greater relative importance in the brass industry than the electric steel furnace does in the steel industry, and has reached this position in a much shorter time.

Of commercially important non-ferrous metals and alloys, other than brass and bronze, there have already been mentioned the nickel alloys, silver and platinum. Aluminium remains to be considered. The electric melting of aluminium has not progressed as far as that of brass and bronze. The large latent heat of fusion of aluminium makes it require a good deal of energy for melting, theory calling for twice as much energy to melt aluminium and heat it to pouring temperature as to melt and heat yellow brass to its much higher pouring temperature. Hence production is slower on aluminium than on brass. Moreover, at these low temperatures fuel-fired furnaces are relatively more efficient than they are at higher temperatures, so that the electric furnace has stronger competition. A large Baily furnace has been tried out on the preparation of aluminium-alloy ingots and worked well on aluminium zinc alloys, as it reduced zinc loss.

Several aluminium foundries use Baily furnaces on aluminium, however, and the General Electric Company uses its furnace for that purpose. The Detroit furnace also has given good results on aluminium. The General Electric Company is developing an aluminium furnace with a Ni-Cr resistor which ought to be feasible at the temperature involved, and its use should throw light on the interesting question of whether a more or less reducing atmosphere, as in a carbon resistor or arc furnace, or an oxidising one, as in the Ni-Cr furnace, is the better for aluminium.

On the usual aluminium alloys the electric furnace does not show any particular saving in metal. Its economical use in comparison with fuel-fired furnaces will depend on prices of fuel and of power. It is of service where close temperature control is essential.

Baily furnaces of 100 kw., however, are used successfully in the production of an alloy of 85 per cent. zinc, 10 copper and 5 aluminium.

For alloys of still lower melting points, babbitt, solder, type metal, etc., there are metallic resistor furnaces, but they have found little use.

The fundamental requirement for good performance of an electric furnace on non-ferrous alloys is that the furnace be fitted for its job. Under some plant conditions half a dozen different furnaces might give equally good results, more commonly only a couple ought to be considered, often one is pre-eminently suitable, and sometimes (but in the case of brass and bronze very rarely) no electric furnace can properly compete with the most suitable fuel-fired furnace. Nevertheless, experience has shown that an electric furnace, metallurgically suited to its job, once installed, generally stays in service, even though the melting cost sheets may show no saving.

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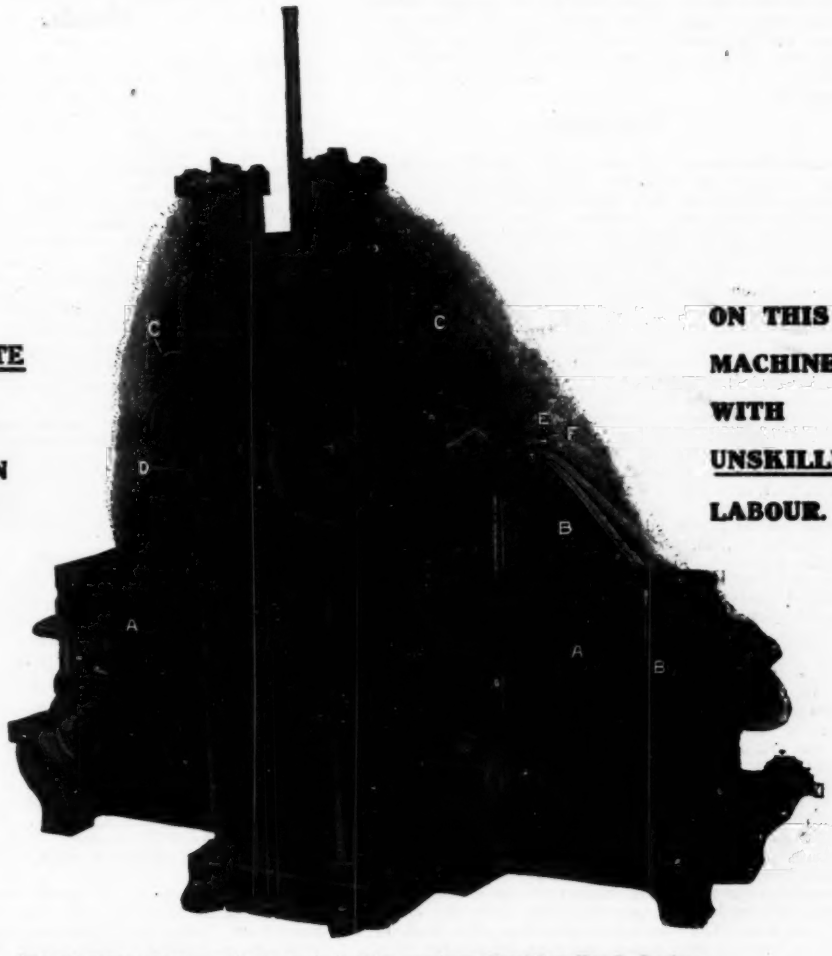

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IRON AND STEEL MARKETS.

Pig-iron.

From a retrospective point of view the past quarter, as affecting the pig-iron industry, has been without parallel in market stagnation and idle production ever experienced in the annals of British trade, makers for many weeks having had entirely to rely upon stock resources to supply the limited needs of consumers, with practically every furnace in the country cold. Even with the resumption of fuel supplies, it is by no means certain that business will immediately revive, at all events, until cheaper costs of production are assured. All the probabilities, however, point to some fairly substantial reductions in the prices of raw materials in the near future, which will enable pig-iron smelters ultimately to meet their Continental and American rivals on much more equal terms. There is, however, a general disposition in the pig-iron trade to await developments, a waiting policy being deemed the most prudent course to adopt until the position becomes more clearly defined. In the meantime, the official minimum price for No. 3 Cleveland foundry iron is 120s. per ton, but it cannot be bought under 135s., and then buyers must take an equal proportion of No. 4 foundry at the same figure. Thus it would create no surprise if makers were to increase the official minimum to a figure more nearly approximating to present values. But whatever happens, it seems doubtful if any addition will be made to the price of the lower qualities, for even at 117s. 6d. per ton for No. 4 forge and mottled and 115s. for white iron it is difficult to find a market.

Tinplates.

Notwithstanding the more settled labour conditions now restored, the situation in the tinplate trade has, so far, undergone little improvement, the volume of inquiries being on a restricted scale, while neither buyers nor sellers display much inclination to close fresh business. There seems no prospect of an immediate resumption of operations at the steel and tinplate works, for the reason that there is a lack of orders, although a few firms have made preparations to restart directly supplies of fuel come forward. In this connection it is said that these works have ample supplies of bars and other raw materials. It is of interest to note that up to within a fortnight ago a few works had been operating throughout the long coal stoppage—some on foreign bars and fuel obtained from other works that were compelled to cease operations in consequence of the high costs of production. Stock plates are in quiet demand, and realise from 27s. to 27s. 6d. basis for cokes, net cash, f.o.t. at works. Wasters are becoming scarce, and prices are largely a matter of negotiation. CW. 14 by 20 are quoted at 19s. 6d. to 21s. per box; CW. 28 by 20 at 39s. to 40s. 6d. per box; CW. 14 by 18 at 16s. 6d. to 17s. per box; and CW. 20 by 10 at 22s 6d. to 23s. 6d. per box; all f.o.t. Ternes are a very slow trade. 26s. 6d. basis is nominally the current figure for usual specifications.

Finished Iron.

The recent substantial reductions in quotations for marked and common bars has so far not yet appreciably affected demand for these materials, although as far as the first named qualities are concerned it is understood that makers have considerable contracts still uncompleted with which to restart rolling at mills. Will regular fuel supplies assured in the future, little delay is anticipated in resuming work in full swing by makers of marked bars, which, it should be noted, are not so greatly affected by outside competition as is the case with the lower grade brands. Midland manufacturers express dissatisfaction with the action of the Lancashire makers in reducing their price for crown bars to £16. They have had to follow this lead, of course, because they recognised that the market must come down nearer to the economic level. At present, however, some of them fail to see how they are to produce reputable bars at such a price without losing heavily. One of the essentials, of course, is a considerable reduction in raw materials, and so far one of them (pig-iron) does not give much indication of any move in that direction. Gas strip makers are in a very difficult position owing to the competition of strip made from imported steel, and they also are faced with the hard problem of finding ways and means to give an adequate reduction. Consequently movements in strip material have of late shown a downward tendency, prices having declined about 40s. per ton, current quotations now ruling about £20. In Scotland, though some employés at finished iron works are prepared to sacrifice the usual holidays in view of the decreased trade now possible, closing down for the "Fair" will be fairly general in view of the lack of new orders and the idle conditions at the Clydeside shipbuilding establishments.

Steel.

In few industrial centres has the news of the settlement of the prolonged miners' dispute been welcomed with more satisfaction than in Sheffield, where the total suspension of fuel supplies has inflicted almost irretrievable loss on the staple steel trades of the district. This effect has been specially marked in the finished steel branches, where demand is still fairly good, and a return to normal fuel conditions should assure steady employment, as stocks of other materials are available, and a restart will be general when coal can be obtained. On the other hand, open hearth steel plants are idle, and it would be scarcely worth while to relight the furnaces in the present state of order books. No one is buying this class of material until there is a greater feeling of certainty. A similar state of affairs exists in the crucible steel branches, where the position is such at present that prices scarcely exist; they depend upon the circumstances of the moment and of the firms trying to do business. The amicable settlement of the wages question in the engineering branches has stimulated also a more active tendency in these departments, which during the strike have been practically dependent upon outcrop coal supplies, while others have been kept going by electrical power, now an important factor in industrial organisation in Sheffield and elsewhere.

Metals.

Copper.—Messrs. Henry Bath & Son, Limited, in their fortnightly metal report, under date July 1, state:—The low level of prices to-day continues to militate against the profitable working of mines, with the result that production in many directions continues to be curtailed or is entirely stopped. In America, as is usual at this time of the year, men are leaving the mines for the harvest fields in considerable numbers. The copper market continued to droop until the 24th ulto., when £69 7s. 6d. and £69 15s. were accepted for cash and three months respectively. Since then a steadier tone has been experienced, and the closing prices to-day show an advance from the lowest of over £2 per ton. The demand from home consumers has naturally been small, but the Continent has been buying fairly steadily. Now that the coal strike is over a good home demand is anticipated as soon as supplies of fuel become available. Electrolytic copper has been quoted as low as £73 10s. to £75, but it has since had a good recovery. The week's markets opened steady with prices unchanged on balance. Electrolytic and wire bar advanced to £75 10s. to £77 10s. Closing prices:—Cash: Wednesday, £70 5s.; Thursday, £71 2s. 6d.; Friday, £71 17s. 6d.; Monday, £71 17s. 6d.; Tuesday, £72 5s. Three Months: Wednesday, £70 10s.; Thursday, £71 10s.; Friday, £72 2s. 6d.; Monday, £72 2s. 6d.; Tuesday, £72 5s.

Tin.—The non-receipt of cables from the East at Monday's opening market had little effect upon business, the tone throughout remaining firm and active. The demand for near delivery tin was in good volume, and values showed a sharp recovery, the upward movement being stimulated by the publication of favourable monthly statistics, showing a substantial decrease in tonnage of visible supplies. The inquiry for the forward position was well maintained, middle July realising £170 10s.; August, £171 5s. to £172 10s.; September, £171 5s.; end September, £171 10s. to £173; Australian, £171 5s.; Banca, £174; English, £170; bars, £172; refined, £171 to £172. Closing prices:—Cash: Wednesday, £166; Thursday, £167; Friday, £169; Monday, £170 15s.; Tuesday, £172 5s. Three Months: Wednesday, £168 5s.; Thursday, £169 5s.; Friday, £171; Monday, £172 15s.; Tuesday, £174 5s.

Spelter.—Business in the spelter market of late has shown a quiet tendency, and this week prices have inclined to lower levels following some stagnation in consumptive demand. The Metal Exchange returns show an increase of stocks on the 1st inst. of 1,270 tons, the figures being 19,000 tons against 17,730 tons on April 30. Monday's prices showed a decline of 12s. 6d. to 7s. 6d., July selling £26 15s. to £26 10s.; August, £27; September, £27 5s.; October, £25. Closing prices:—Wednesday, £27; Thursday, £27 10s.; Friday, £27 7s. 6d.; Monday, £26 15s.; Tuesday, £26 15s.

Lead.—Consumption of the metal has been fairly good of late, and is likely to improve as labour gets to work again. Supplies have been moderate, principally from Spain, but include about 700 tons from Africa. There is a difference of opinion as to the prospects of early shipments from America, but lead there, at present at any rate, is firmly held. The Metal Exchange returns show stocks on May 31 as 14,138 tons, against 18,127 on April 30, a decrease for the month of 3,989 tons. English closing prices:—Wednesday £24 10s.; Thursday, £24 10s.; Friday, £24 10s.; Monday, £24 10s.; Tuesday, £24 10s